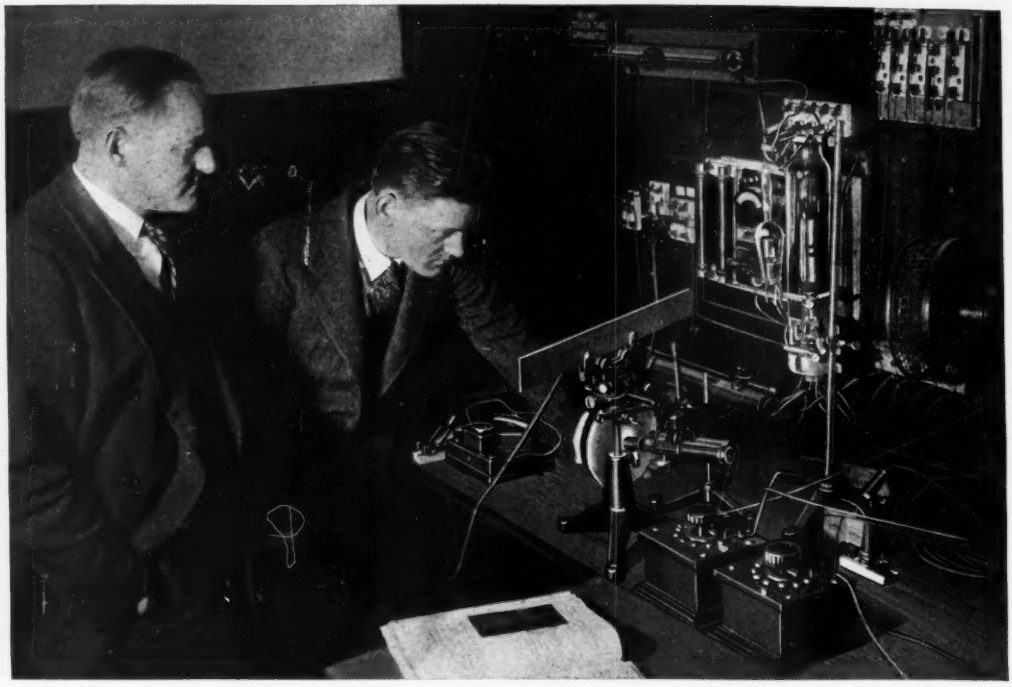
BELL LABORATORIES RECORD

VOLUME TEN—NUMBER TWO

for

OCTOBER

1931



Measuring One Trillionth of an Atmosphere

By EDWIN K. JAYCOX
Physical Research

EVEN when the number of air molecules in any space has been decreased by a factor of one trillion below that at atmospheric pressure, there still remain about thirty million molecules in each cubic centimeter. The molecules themselves, however, are so small that at this concentration they rarely collide with each other. In tubes with such a high vacuum, the molecules have negligible effect on the thermionic or photoelectric actions which are of so much importance today to physicists and electrical engineers. When the concentration is about one thousand fold greater, noticeable effects are obtained; for example, some of the molecules striking the various surfaces in the tube are adsorbed. As J. A. Becker[1] and L. H. Germer[2] have shown, a very small amount of adsorbed material — less than one molecular layer — on the surface of the thermionic or photoelectric emitter is often sufficient to change the electron emission or other characteristics of these surfaces enormously.

The gas molecules which move about in the space are occasionally struck by electrons travelling to the plate. If this collision is violent enough the gas molecule loses one of its electrons and is then positively charged, or *ionized*. The number of such positively charged molecules, or positive

[1] RECORD, *September*, 1927, *p.* 12.
[2] *Bell System Technical Journal, July*, 1929.

ions, formed is proportional to the gas pressure. When the number of molecules per cubic centimeter is greater than thirty billion, then the number of positive ions formed is large enough to exert a marked change in the type of discharge observed.

In making studies of phenomena requiring a high degree of vacuum, it is important that the physicist have a knowledge of the degree of pressure within the apparatus with which he is working. This pressure can be determined by measuring the number of positive ions produced by collisions with a known electron stream. An ionization manometer for accomplishing this was invented by O. E. Buckley in 1916.[3] In its original form and later modifications, it has been used since that time for measuring gas pressures on pump stations and in sealed-off tubes.

An ionization manometer of new design has been recently developed by H. W. Weinhart and the present author. In it have been incorporated features of previous designs by Buckley, and Dushman and Found, as well as certain improvements and new features, which give the gauge a high degree of sensitivity in the measurement of pressure in vacuum apparatus.

The essential parts of an ionization manometer are: a thermionic filament or cathode; an anode for collecting electrons; and a positive-ion collector. When measuring gas pressure, the electron collector is maintained at a potential of a hundred volts or more positive to the filament, and the positive-ion collector at 6 to 9 volts negative. A current sent through the filament heats it to a temperature at which electrons are emitted. Because of the positive potential on the electron collector these electrons are accelerated toward it. If there is any gas present, between the cathode and the anode, collisions will occur between the electrons and atoms or molecules of gas. The positive ions produced thereby are drawn to the positive-ion collector which is maintained at a negative potential. The number of collisions which will occur in a given time for a given electron current and hence the number of positive ions formed is proportional to the number of gas atoms or molecules present. The number of positive ions that will reach the collector, or the positive-ion current is therefore proportional to the pressure of gas.

The greater the positive-ion yield per electron at a given gas pressure, the more sensitive will be the gauge. Great sensitivity is desirable as it enables the use of less delicate instru-

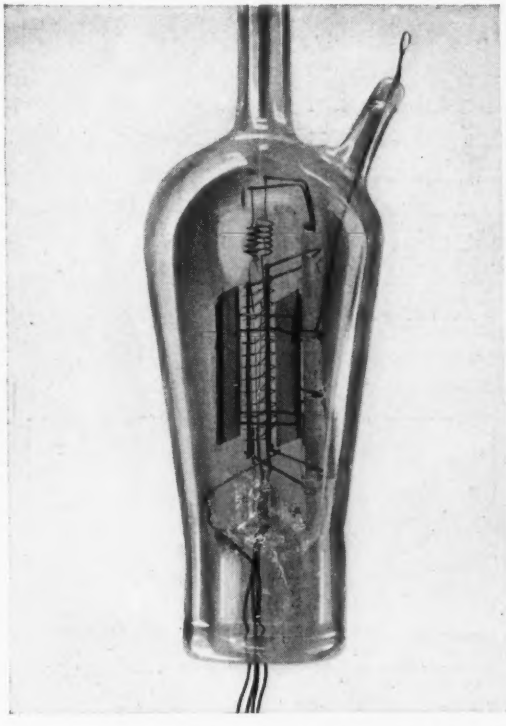


Fig. 1—The ionization manometer

[3] RECORD, *September*, 1926, *p.* 26.

ments for measuring positive-ion currents. An important factor in establishing the sensitivity is the geometrical arrangement of the gauge elements. One obvious way of increasing the positive-ion yield is to increase the length of the path that an electron must traverse before it reaches its collector. This can be accomplished by increasing the distance between the filament and the electron collector, or more conveniently by reducing the size of the electron collector to such an extent that most of the electrons reach the collector only after gyrating several times about it. But in this respect one is limited, as the swinging of the electrons back and forth constitutes a condition favorable to the production of Barkhausen oscillations. When these occur the potential of the positive-ion collector oscillates at a high frequency. For part of a cycle its potential may become positive and it will then collect electrons as well as positive ions. In fact it may happen that this electron current exceeds the positive-ion current so that the rather anomalous and startling condition results in which an electron current is observed to flow to a structure whose applied or mean potential is as much as 20 volts negative with respect to the filament.

After extensive experiments with

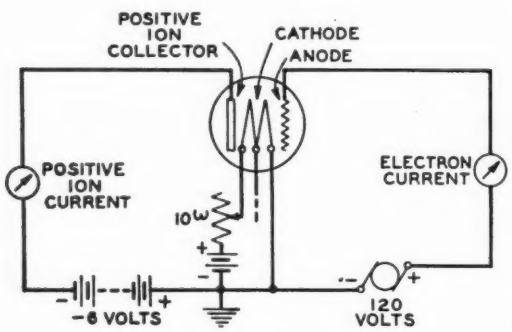


Fig. 2—General circuit for operation of ionization manometer

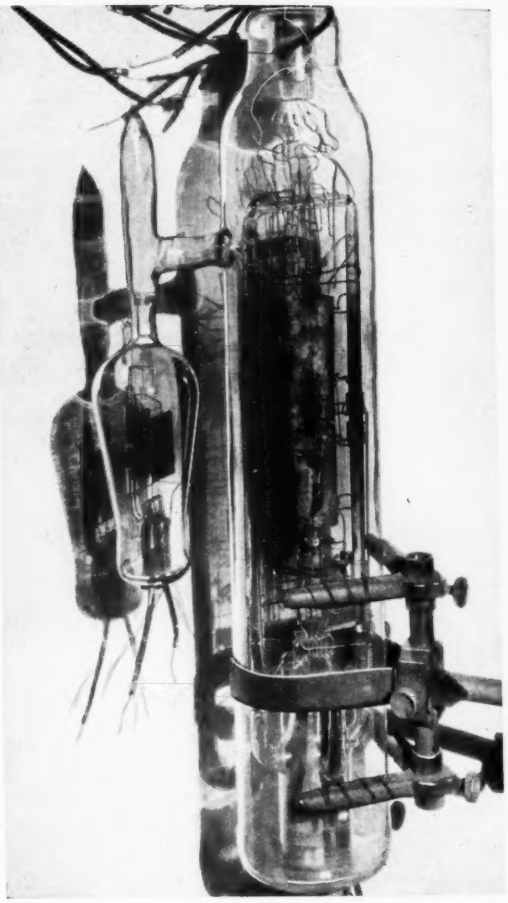


Fig. 3—Tube for study of thermionic characteristics of thorium on tungsten. Thorium is applied to a tungsten ribbon by evaporation from a pure thorium filament. Ionization manometer is attached

gauges of a number of designs it was found that the type of structure employed in the standard manometer, now in use on pump stations, was the most satisfactory, but was not so sensitive as other types. It was considered desirable, however, to sacrifice something in the way of sensitivity in order to insure complete reliability. Accordingly, a design of gauge was adopted whose geometrical arrangement of the elements was the same as in the standard manometer but in which were embodied several improvements. These

are (1) improved insulation which extends the range of the gauge below the minimum pressures which are obtainable with present-day vacuum technique, and permits a more thorough out-gassing of the gauge parts without destroying the insulation; (2) the use of a thoriated tungsten filament instead of a coated filament for measuring pressures in sealed-off tubes; (3) the mounting of the filament in two parts either or both of which can be used, which feature tends to prolong the life of the manometer.

The new manometer as finally adopted is shown in the photograph of Figure 1. It consists of a filament, grid, plate, supporting stem, and bulb with a tubulation for sealing to the apparatus in which it is desired to measure the pressure. When the gauge is to be used for measuring the pressure in a sealed-off tube the filament is made of .004" thoriated tungsten wire. This material has been found to give the best results for operation at very low pressures. It can be readily and thoroughly out-gassed and, unlike an oxide coated filament, when once out-gassed it does not again become a source of gas.

For use on a pump station a standard B-4 oxide-coated filament is used. Here it is often subjected to a very rough treatment at relatively high pressures. Under such conditions it is far superior to thoriated tungsten. The filament, in either case, is mounted in the form of an M with connections at each end and a third connection at its midpoint. This permits the use of the entire filament or either half as cathode, and if one half burns out the gauge can still be used. Spiral springs of .010" molybdenum wire are used to keep the filament in position.

A nickel grid serves as the anode and its function is to collect the electrons emitted from the filament. It is maintained at a positive potential of 100 to 250 volts with respect to the cathode.

Two electrically connected nickel plates, one on either side of the grid-filament structure parallel to each other, form the positive-ion collector which is maintained at 6 to 9 volts negative to the filament. Good insulation is insured by placing glass collars on the supporting arbor. These prevent the deposition of a continuous film of conducting material on the arbor. The lead-in wire is brought out through a separate ear of the glass bulb.

Due to the structure of the gauge its parts can be extremely well out-gassed. This is accomplished by first baking the gauge at 400° C. for an hour or more. The grid and plates are then heated to incandescence by electron bombardment until they no longer evolve appreciable amounts of gas. When the gauge is to be used

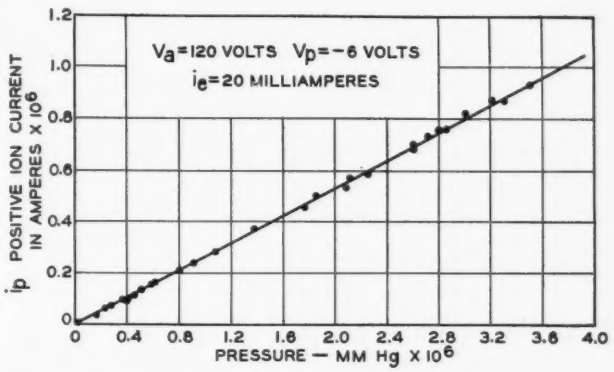


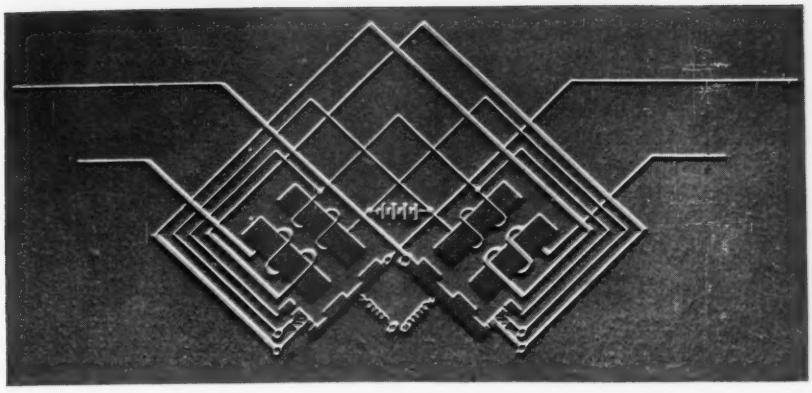
Fig. 4—Positive-ion current vs. pressure when 120 volts is maintained at anode (electron collector) and −6 volts at positive-ion collector

with a sealed-off tube the out-gassing is very important, for if low pressures are to be maintained after the seal-off, the gauge must not act as a source of gas. In many cases the residual gas after seal-off is cleaned up by heating the filament (thoriated tungsten) at a high temperature, 2400 to 2600 degrees absolute. At these temperatures thorium and tungsten evaporate and the vapors combine with certain residual gases, thereby reducing the pressure.

Such usage of course tends to shorten the life of the filament. It is in fact, the chief reason why the filament is mounted in two parts, one half of which can be held in reserve. By this clean-up process the pressure can often be reduced by a factor of 100 to 1000 below that at the time of seal-off. Likewise, while experimenting with the main tube, if gas is generated it can be readily cleaned up. The ionization manometer is not only of value as a pressure indicator but it also serves as a means of controlling the amount of gas in the system.

Measurements of pressure less than one trillionth of normal atmosphere may be made with this manometer. At the other end of the scale its pressure limit is about one hundred-thousandth of an atmosphere. Expressed in the pressure unit with which molecular concentration in vacuum apparatus is usually measured, its range extends from less than 10^{-9} mm. of mercury to 10^{-2} mm. of mercury. At a pressure of one trillionth of an atmosphere the positive-ion current is very small, about one two-billionth of an ampere. The insulation has been made adequate to enable the measurement of these minute currents and the range of the gauge has been extended downward below that of other designs.

The most important use for this gauge is to measure pressures in sealed-off tubes where pressures of the very lowest order, 10^{-9} mm. of mercury or one trillionth of an atmosphere, can be obtained with proper treatment of the tubes. While pressures on pump stations cannot ordinarily be reduced to this low value, recent advances in pumping technique have made it possible to obtain pressures of less than 10^{-7} mm. of mercury or one ten-billionth of an atmosphere on the pumps. The satisfactory measurement of even these pressures requires the use of an improved type of manometer. The ionization manometer which has been described has been successful in fulfilling practically all of the requirements of present-day measurements of gas pressures in vacuum apparatus.



The Single-Line Telegraph Repeater

By G. C. CUMMINGS
Toll Systems Development

TO him who is familiar with the peculiar use of the word "single" in telegraph parlance, the name "single-line telegraph repeater" at once suggests most of the properties of the apparatus which it names. To appreciate the function of a "telegraph repeater" requires only a familiarity with any branch of electrical communication. Clearly it is an assemblage of apparatus arranged to retransmit telegraph signals from one circuit to another when the circuits cannot satisfactorily be directly connected together. Such circuits are those of widely differing impedance characteristics, and those whose combined length is too great.

The word "single" has been in special use in telegraphy for forty years or so to distinguish a line or telegraph set which operates on simple make-and-break signals and carries but one communication in one direction at a time, from a line or set which carries more than one communication at a time. Of the latter sort are "duplex" and "quadruplex" equipments which carry respectively one and two communications in each direction at one time. In the Bell System no quadruplex equipment is used, but there are many lines employing duplex equipment. More than ninety percent of this duplex equipment, however, is operated by a method termed "half-duplex", to transmit in only one direction at a time and to permit instant reversal of the direction of transmission.

Since most line equipment is thus arranged to transmit but one communication in one direction at a time, and the single-line repeater is arranged to retransmit in the same way, it was early found desirable to use single-line repeaters to join or terminate sections of telegraph line whose operation is half-duplex. Today a channel employing any of the standard schemes of telegraph transmission—either direct current, or voice-frequency or high-frequency carrier current—may be half-duplex operated. Any of these channels may for interconnection purposes employ single-line repeaters,—

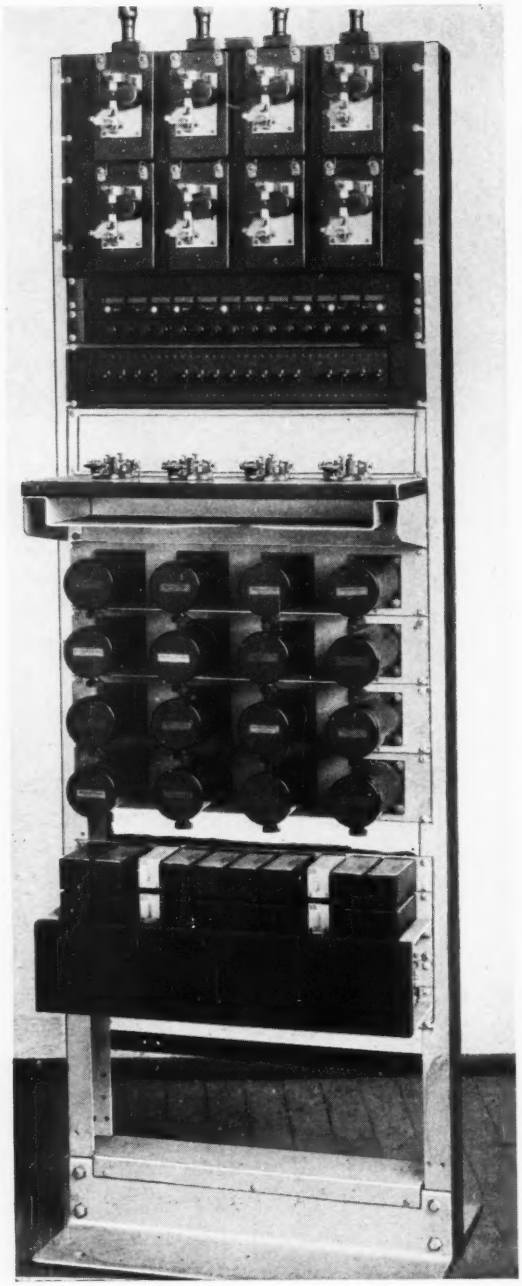


Fig. 1—Four single-line repeaters are mounted in one low relay-rack bay

in the case of carrier channels, before modulation or after demodulation. Since such channels are very numerous in the Bell System plant, and quite diverse in their characteristics, they combine to require great versatility in the performance of the single-line repeater.

The simplest conception of the single-line repeater's function is displayed in Figure 2. The earliest repeaters designed to fill this function consisted of two simple relays. Each of the two lines which the repeater connected together was carried through a winding of one of the relays and through a front contact of the other. Additional windings and contacts were so connected to a local battery that transmission could always take place from an open-circuited line to a closed-circuited line. Even as recently as 1920 no very complicated circuit was required for this purpose.

The last ten years, however, have seen an intensive development of the telegraph art and the adoption of apparatus and systems which have added a multitude of rigorous requirements to be filled by the single-line repeater. During this time there have come into extensive use cable systems employing small-gauge conductors and carrier systems operating at a variety of frequencies. Thus the application of the single-line repeater is no longer confined to simple circuits such as the subscriber's loop circuit, which approximates that shown in Figure 2. The repeater is also to be found working into composited open-wire lines, composited 13-gauge cable lines, simplexed phantom 19-gauge cable lines, and non-composited lines, and tying any of these into carrier-telegraph channels.

Concurrently there has been a rapid increase in telegraph speeds. In 1900 a telegraph operator seldom averaged more than ten or twelve dots per second. The advent of semi-automatic keys of various forms, making the

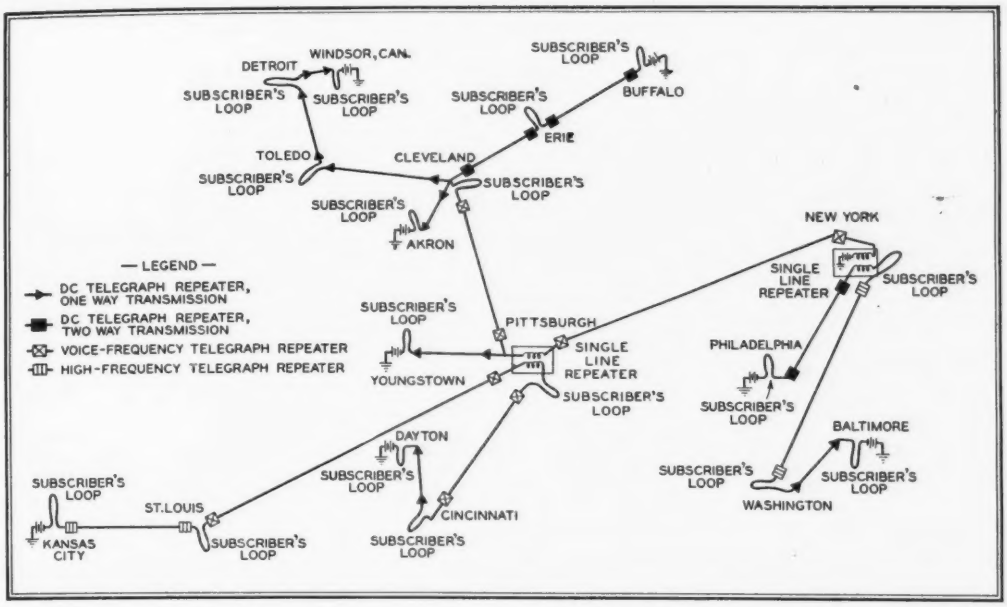


Fig. 3—This telegraph contract network employs two single-line repeaters

dots by a vibrating reed or otherwise, increased the signalling speed to sixteen or eighteen dots per second by 1905. The first printing telegraph apparatus in the Bell System also operated at about this speed, but the carrier and metallic cable systems further increased it to twenty-four dots per second. Accordingly the repeater is now required to function at any signalling speed from five to twenty-five dots per second, and to convert signals often of poorer quality into signals of better quality than ever before.

In order to meet this wide variety of rigorous requirements, the relays used in the repeater have been changed from a neutral make-and-break type to a high-grade polarized type, and the circuit has evolved into one of considerable complexity. Adjustment of two resistances alone adapts the repeater to function satisfactorily under almost any required condition. In the embodiment standardized in 1929, four repeaters are mounted in a low relay-rack bay, as shown in Figure 1.

Any one of the ramified contract telegraph networks of the Bell System will illustrate the large place of the single-line repeater in the telegraph system. Twenty-five years ago a circuit from New York to St. Louis via Chicago, with one or two subscribers' connections at New York, Pittsburgh, Chicago, and St Louis, was considered a large network, difficult to maintain. Today such contract networks are the rule. Typical of them is that shown in Figure 3, embracing seventeen cities. Its

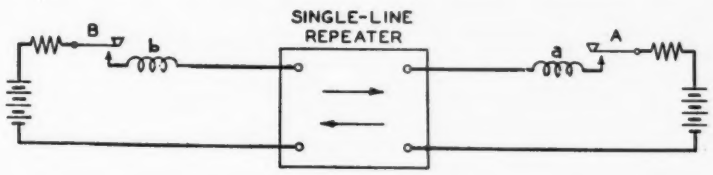
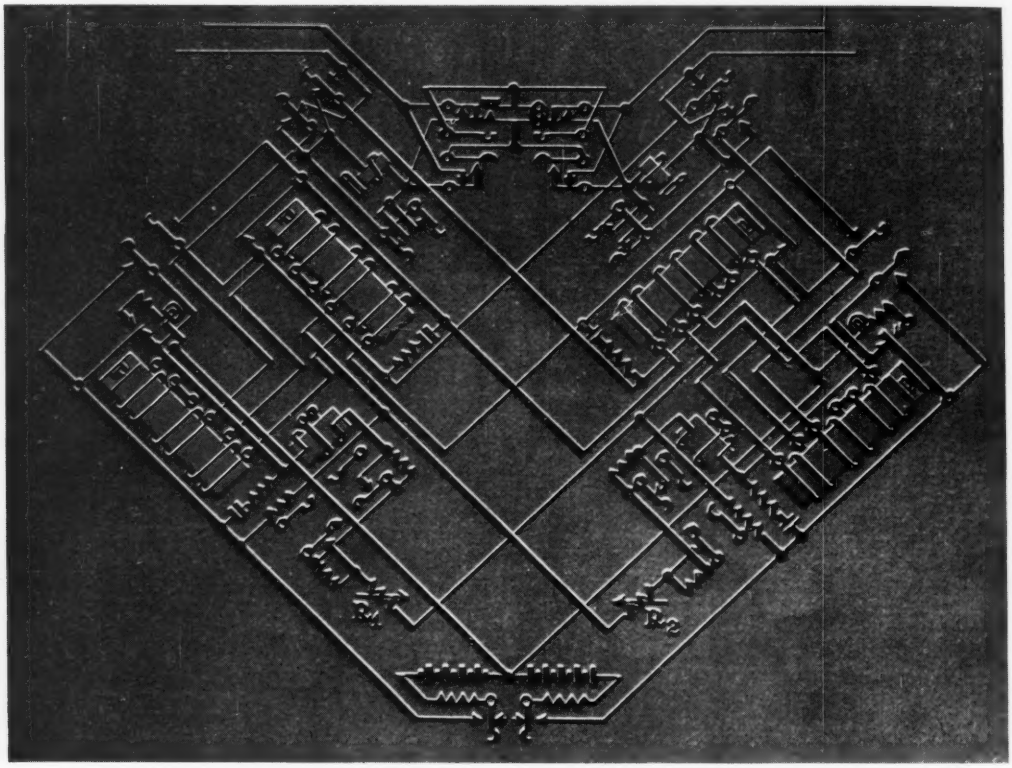


Fig. 2—The simplest conception of the single-line repeater is that of apparatus which will retransmit signals from key B to receiving relay a, or from key A to receiving relay b

operation is by printing telegraph at a speed of sixty words per minute, and almost every kind of telegraph communication channel is used. Two single-line repeaters, at two important junction points, are used to effect three-way or four-way connections.

It is remarkable that no rotary regenerative repeater* is required in this network. The use of this far more expensive repeater is justified only where telegraph signals require a complete rejuvenation. That no such repeater appears in this network testifies to the degree of perfection which has been reached in maintaining the Bell System's telegraph service at a uniformly high level of quality, and to the dependability of the single-line repeater for most retransmitting purposes in telegraphy.

* RECORD, *August*, 1930, *p.* 570.



The circuit diagrams of single-line repeaters shown above and in the headpiece have been rearranged in this symmetrical form from the standard circuit drawings. By a photographic process involving a print from positive and negative transparencies, slightly offset, the Laboratories' Photographic Department has secured a novel effect of relief

A Small Subscriber Set

By FRANK LOHMEYER
Telephone Apparatus Development

WIDESPREAD efforts have been made in recent years to improve the appearance of telephone apparatus and equipment, particularly that which is to be installed at subscribers' stations. Some of the results of these endeavors are evident in the more recently designed private branch exchanges, already described in the RECORD.* The newly designed hand telephone set with oval base is another illustration. Of great importance, because of its effect on a large number of subscribers, is the improvement in the appearance of the subscriber set — popularly called the "bell box" — one of which is usually required for every telephone handset or desk stand.

Although an effort is made by the telephone companies to locate the subscriber set in concealed places such as under a desk or table, on the wall behind furniture, or in an enclosure provided for it in the wall, it is not always convenient, due to local conditions at the station, to do so. It is important, therefore, that the subscriber set be as small as possible and as pleasing in appearance as is commensurate with dependable operation and reasonable cost.

For the proper functioning of the telephone circuit, the subset, as it is called for short, must include besides the bell, or ringer, an induction coil, a condenser, and terminals suitable for making the necessary connections between the incoming line, the handset or desk stand, and the equipment within the subset. In the oldset — shown at the right of Figure 1 — this equipment was arranged in a simple straightforward manner, and a metal housing was constructed of a size to inclose it comfortably. On a punched metal base arranged for vertical mounting was the condenser, at the top, below it the induction coil, and below that, the ringer. Terminals for the induction coil were mounted on its two wooden end pieces, and additional terminal space was provided by an insulated strip which held the condenser in place. The cover of the subset was hinged and the cord for the telephone passed through an embossed hole in one side of it. Space was provided for a relay and switchhook, the former being required at four-party selective ringing stations and the latter for wall sets.

For the great majority of the subsets used, neither a relay or switchhook is required. In redesigning the box, therefore, it seemed desirable to take advantage of the possibility of the smaller overall size their omission would permit. The major part of the demand for subsets would thus be met by the new design and the older design could be retained for use with wall

* RECORD, *February*, 1930, *p.* 278.
* RECORD, *May*, 1930, *p.* 416.

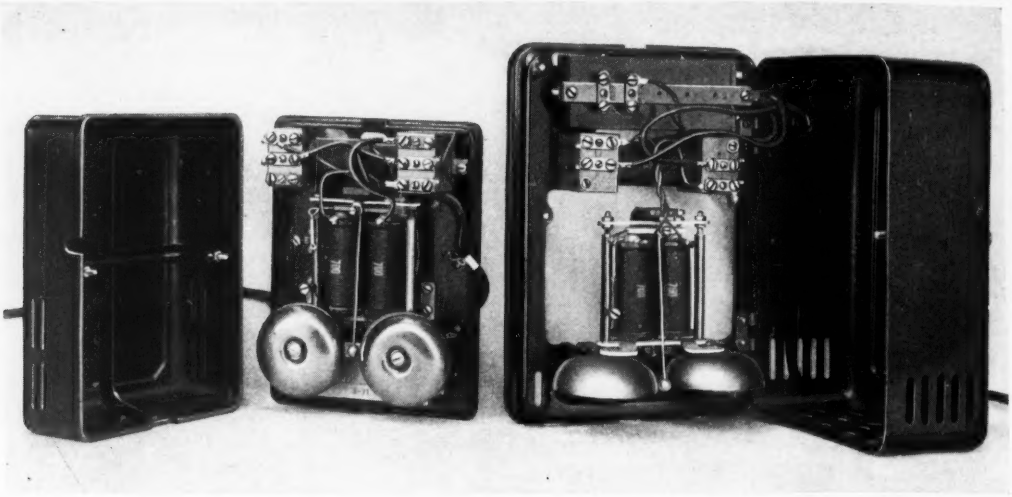


Fig. 1—The compact arrangement of the new set (left) permits a smaller overall size, and the moulded cover presents a better appearance than the older set (right)

sets or four-party selective lines. In the effort to provide a compact arrangement, the gongs furnished perhaps the most difficult obstacle. Three modifications in their arrangement were incorporated in the new set, shown at the left of Figure 1. The gongs were first made somewhat smaller in diameter and then mounted parallel to the plane of the ringer coils, which made a shallower depth possible. To decrease further the possible depth, a depression was formed at the centers of the gongs, where the mounting screws pass through, to allow the top of the screws to be flush with the gongs.

With the new arrangement the condenser could be mounted between the gongs and the base. To get rid of the terminal strip formerly mounted over the condenser, the two terminals required were mounted on the ends of the induction coil beside the coil terminals already located there. This necessitated a new method of mounting for the coil since with the old design the mounting screws utilized this space. Lugs driven into the wooden ends are employed to fasten the coil to the base of the new set.

It was now found that with the considerably reduced overall dimensions, a steel cover and base could not be used. These parts came so much nearer the ringer that if made of steel they formed a magnetic shunt of sufficiently low reluctance to interfere with its operation. Non-magnetic materials were required to avoid this, and the base of the new subset was, therefore, made of brass and the cover of phenol plastic. Non-magnetic metals, such as brass, were considered for the cover but were rejected for reasons of economy and other advantages of phenol plastic.

The corners of the new moulded cover were made twice as thick as the sides, and reinforcing ribs were provided so as to secure sufficient strength to withstand the shocks to which the cover might be submitted in shipment or when installed. The cover is completely removable instead of being hinged, which is of considerable advantage in station installation and repair work, and has a notch on one

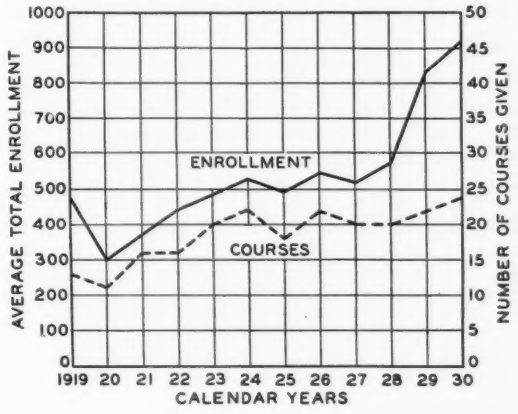
edge through which passes the cord to the telephone. The moulded cover has proved to be not only better looking but cheaper—largely because the finishing operations required by the metal cover are not needed.

The new subset, which occupies less than half the volume of the old, presents an improved appearance because of the lustrous finish of the phenol-plastic cover and can be produced at a lower cost than the older.

Out-of-Hour Courses for the coming season will open during the week beginning October 19 for their thirteenth year. Announcements in pamphlet form, giving a description of each course, have already been distributed, and applications for enrollment must be submitted before the fifth of this month. As usual classes will be conducted by members of the various departments of the Laboratories. Most of the work will be carried on in the new quarters of the Educational Department on the 4th floor of the Keasbey Building which, remodelled as announced on page iii of this issue, will be known as Section I.

During the twelve years that Out-of-Hour Courses have been offered, more than 4500 of the Laboratories staff have taken one or more of them. This number records an appreciation of these educational opportunities in an unmistakable manner. As shown in the graph below both the average enrollment and the number of courses offered have shown an almost uninterrupted growth since the beginning year of 1919. The popularity of the courses is even greater than indicated by the curves because each year there have been more applicants than could be accommodated with available facilities. During the last season some two hundred applications could not be accepted.

Courses offered this coming season are in general the same as last year, with the addition of three new courses — Alternating Current Measurements, Piezo-Electricity, and Dielectrics.



Telephone Apparatus for the Hard of Hearing

By A. N. HOLDEN
Bureau of Publication

IT is tantalizing for a person hard of hearing to feel that a voice which may have crossed the continent is stopped just as it reaches his ear. In contrast to the task of crossing such barriers of space, entering his ear seems a small thing to ask of a voice. From an early day, therefore, the Bell System has tried to provide means for opening to the hard of hearing the field of conversation by telephone, with the great reach of contact it contains.

Fig. 1—In an installation of the No. 23-A Amplifier, only the control equipment need be mounted near the telephone

The effects upon acuity of hearing which different disorders produce can be grouped as those causing a general lowering of sensitivity over the entire range of audible frequencies, those causing distortion by affecting the sensitivity at certain frequencies more than at others, and those causing subjective disturbances in the ear itself which blur or obscure sounds of external origin by adding other sounds. So varied are these kinds of defective hearing that it might be supposed impracticable to design standard telephone equipment which would be serviceable to any great number of sufferers. That this is fortunately not the case is attested by the many telephone subscribers for whom the utility of their instruments, and of the millions of instruments that can be connected to theirs, has been preserved by a single device.

Experience has shown that a large proportion of those who are unable to understand ordinary speech suffer from a general lowering of sensitivity without excessive distortion. For these people general amplification will restore the intelligibility of speech sounds. Such is the transmission equivalent of the ordinary telephone connection that many who have difficulty in understanding speech face-to-face

have no difficulty in understanding over the telephone. But there are many others who can understand speech only when its loudness is considerably greater than the telephone ordinarily delivers. It is amplifying equipment to fill this function, therefore, which has been made available to telephone subscribers whose hearing is impaired.

The earliest device embodied a No. 1-A mechanical repeater, installed on the subscriber's premises, which raised the speech level about 10 db. But its cost and maintenance were high, and its transmission characteristic was none too good. The advent of the vacuum tube made it possible to develop apparatus having much-improved characteristics and offering greater and adjustable amplification. Known as the No. 23-A Amplifier, it consists of a single-stage vacuum-tube amplifier, of which the gain can be varied in steps. The vacuum tube and the equipment of its immediately associated circuits are mounted in a housing similar to that of a subscriber set.

Fig. 2—The 27-A Amplifier provides a convenient temporary installation of the equipment of the 23-A Amplifier

The amplifier in its housing and the batteries in their battery box can be mounted anywhere in the room in which the telephone set is located, but the control equipment is mounted adjacent to the set, for ready availability. Here, by a key, the amplifier can be switched into or out of circuit, so that the telephone can be used by either one of impaired or one of normal hearing. By a potentiometer the gain of the amplifier can be increased in five steps from none to its maximum of 21 db, to suit the degree of the listener's deafness and the initial loudness of the speech.

When a subscriber requests this equipment from the telephone company operating in his territory, it is first necessary to find out whether his difficulty in hearing over the telephone is of the type that can be helped by the amplifier. Audiometer tests would be not only elaborate but on this point inconclusive; perfect assurance can be had only from a trial of the apparatus itself. Since an installation of the apparatus in its permanent form is unnecessarily expensive for a trial, it has been designed in a port-

able form, coded as the No. 27-A Amplifier, for temporary use. A single carrying case contains amplifier, batteries, desk stand, and control equipment. Weighing only about thirty-two pounds, it can be conveniently brought to the subscriber's premises, made ready for use by connecting its three-conductor cord in place of the standard desk-stand cord, and left for a trial of several days if desirable. A small hinged door in the top of the case gives the subscriber access to the control equipment without exposing the remainder of the apparatus.

The telephone system is necessarily designed primarily to meet the needs of the average subscriber, and must not be made unsuitable for a large group in order to accommodate a smaller. When, however, both can be suited by such minor adjustments as the addition of these amplifiers, the modifications are more than justified. Typical testimony that they are appreciated comes from a subscriber in Ohio who experienced difficulty in hearing over the telephone. After the amplifying equipment had been installed in his home, he wrote, "For the first time in years, I have been able to hear my children talking to me from the Pacific Coast."

The index to Volume Nine, Bell Laboratories Record, is now available for distribution. Copies may be obtained upon application by letter or memorandum addressed to the Bureau of Publication.

NEWS AND PICTURES *of the* MONTH

If radio waves had eyes, this is what they would see in a last backward glance at the transmitting station before they leaped into space from WABC's 685-foot antenna structure

General News Items

BELL LABORATORIES UNDERTAKES EMPLOYEE COOPERATION IN TELEPHONE SALES

At a meeting in the Auditorium on September 16, Vice-President Charlesworth outlined to the supervisors of the Laboratories the major features of the plan for the Laboratories' cooperation in telephone sales. Having been tried with considerable success for some time by the Associated Companies, the plan has now been extended to include the Headquarters Organization of the A. T. and T. Company, the Western Electric Company, and the Laboratories. M. B. Downing, Vice-President and General Manager of the Manhattan Area of the New York Telephone Company, was present and, with W. A. Kietzman, General Commercial Manager, spoke briefly to the meeting following an address by W. D. Sargent, General Sales Manager.

The public at large, as Mr. Sargent pointed out, have not even yet fully realized the advantages of the telephone nor of the various convenient auxiliary services that are available in the forms of interconnecting P.B.X.'s and various wiring schemes. At considerable cost carpet sweepers are replaced by electric vacuum cleaners, ice boxes by electric refrigerators, but too often the enormous advantage of adequate telephone communication, which may be obtained at a cost that is inconsequential compared to other modernizations, is not appreciated. The low expense and great convenience of extension telephones was also stressed by Mr. Sargent as another of the many possibilities of the extension of telephone service. So many avenues for expansion would seem to greatly augment the possibilities for further telephone sales.

Announcements have already been sent out giving all details of the plan. As Dr. Jewett said in his letter accompanying the booklet describing the plan: "It is but an effort to do in an organized way, and on a larger scale, what many of us have already been doing—utilizing appropriate opportunities for interesting our friends and acquaintances in the convenience and economy of adequate telephone service." Already considerable success has been attained in the short time the plan has been in effect within the A. T. and T. Headquarters Organization, and early returns from the Laboratories give promise of gratifying results.

DR. JEWETT CONVEYS GREETINGS TO FARADAY CENTENNIAL

On September 23, Dr. Jewett extended greetings in behalf of scientific societies in the United States to British scientists gathered for the opening of the Faraday Exhibit. He spoke from Boston and his words were carried over the transatlantic radio-telephone circuit to his hearers in London. The exhibition is held to commemorate the centenary of Michael Faraday's great discoveries in the realm of physical sciences.

In conveying the felicitations of the American scientific societies, Dr. Jewett spoke of the high esteem in which Faraday was held by scientists all over the world. "Although Faraday was of your blood," he stated to his British auditors, "we of other lands yield you nothing in the measure of the respect and admiration in which we hold him. Go where you will in our institutions of learning, in the stately edifices we raise as homes for our scientific societies, or in the more prosaic housing of our scientific industrial establishments, and you will always find evidence of our regard. For he is ever a great and simple man who enriched the world as few others have been privileged to enrich it."

Dr. Jewett also mentioned the peculiar fitness of delivering by transoceanic radiotelephony a tribute to the great British scientist, involving as it does so much of the fruit of Faraday's work.

WABC'S NEW 50-KW TRANSMITTER PLACED IN OPERATION

Station WABC's 50-kilowatt radio transmitter, designed by the Laboratories, was placed in service September 8. It is located in Wayne township near Paterson, New Jersey, and is the first 50-kilowatt installation of Western Electric Company manufacture to be

situated in the metropolitan area.

The latest advances in broadcasting development embodied in the new installation will make the transmitter one of the most efficient and powerful in the country. Instead of the usual antenna suspended between two masts, a single insulated mast is used as a radiating system. It is a lattice-work steel structure rising 685 feet from the ground, more than a hundred feet higher than Washington Monument. At the base it is but 18 inches square and rests on a large porcelain insulator which, in turn, is supported on a concrete foundation. The steelwork widens out to 28 feet at the 250-foot mark where four guys are attached. It then tapers down almost to a point on which rests a 14-inch ball.

The antenna system, which is an outcome of extensive experiments on the part of the Laboratories, increases radiation of the waves along the ground plane and decreases the so-called "sky-wave" radiation. The control effected may be likened to the shade on a suspended incandescent lamp which concentrates the lamp's rays downward and eliminates the useless upward glare. A 40 per cent gain in local field strength is obtained through the use of this radiator. With the usual type of antenna, the power of the transmitter would have to be approximately doubled to effect this increase. This feature gives WABC, which is the key station of the Columbia chain, the greatest field strength of any in the country.

In addition to field-strength gain the new antenna design is expected to lessen fading of radio signals at moderate distances. Fading is the result of interference between the ground-path and sky-path components, and with the decreased skyward radiation, except at the longer distances from the transmitter where the waves strike the Heaviside layer and are reflected at flat angles, interference of this nature is materially reduced. As a result the region in which fading begins to occur should be removed from the station by considerable distance, with a corresponding increase in the reliable service area.

RENOVATED KEASBEY BUILDING OCCUPIED BY LABORATORIES

During the latter part of August the Educational Department moved into its new quarters on the fourth floor of the building at the corner of Bank and West Streets, formerly occupied by the Robert A. Keasbey Company. It is the first step of the Laboratories' occupancy of the property which is made necessary by the loss of floor space resulting from the construction of the elevated railroad through Sections H and G. The third floor and part of the second floor are to be taken over by the Inspection Engineering Department sometime during October. The balance of the second floor will be used by Research Drafting. No decision has yet been made as to the uses to which the remainder of the building will be put.

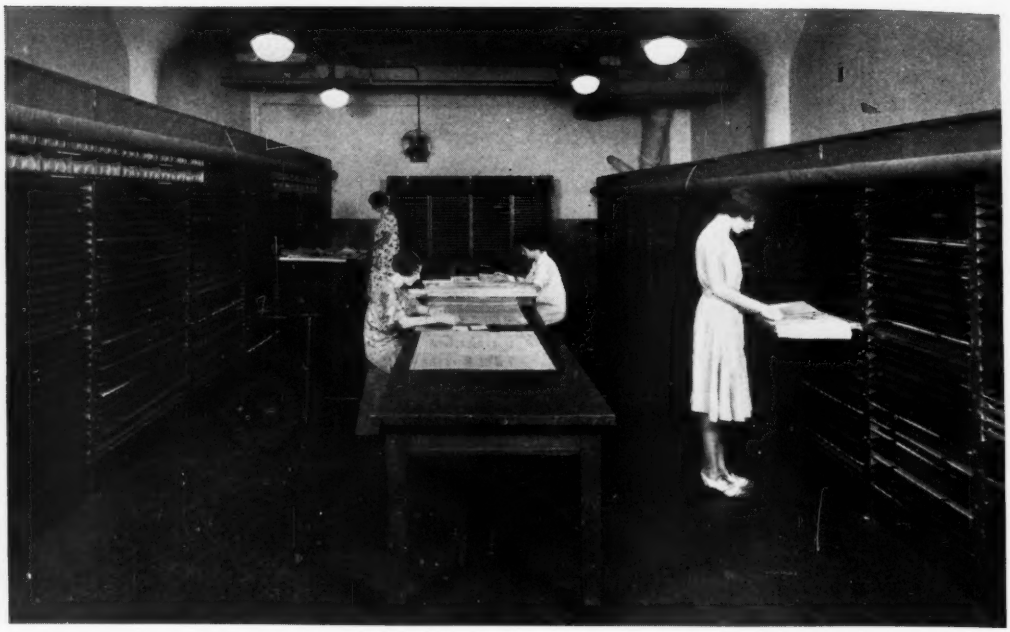
The interior of the building has been entirely altered and renovated by the Building Service Department. New lights, and heating, and drinking fountains have been installed. On the fourth floor which is given over entirely to the work of the Educational Department, partitions have been set up to provide seven class rooms, a cloak room, instructors' offices, and a file room. Large window space in the class rooms insures plenty of daylight, and in one large room not receiving the benefit of direct sunlight, there is a large skylight. In addition, the new ceilings and the upper walls are painted cream to furnish as much illumination as possible. All of the class rooms are fitted with heavy shades for the showing of lantern slides.

With the taking over of the space formerly used by the Keasbey Company, the Laboratories now occupies the entire block bounded by West, Bethune, Washington and Bank Streets. The building is part of the Morgan property leased by the Laboratories in 1927 for a 100-year term. The property included in the lease extends from West Street to the eastern line of the plot on which the Sound Picture Laboratory is constructed, and on the north to the original Western Electric property. When this lease was signed, the Keasbey Company had occupied the building for a number of years and their lease was continued subject to cancellation upon notice. The building was vacated early this year.

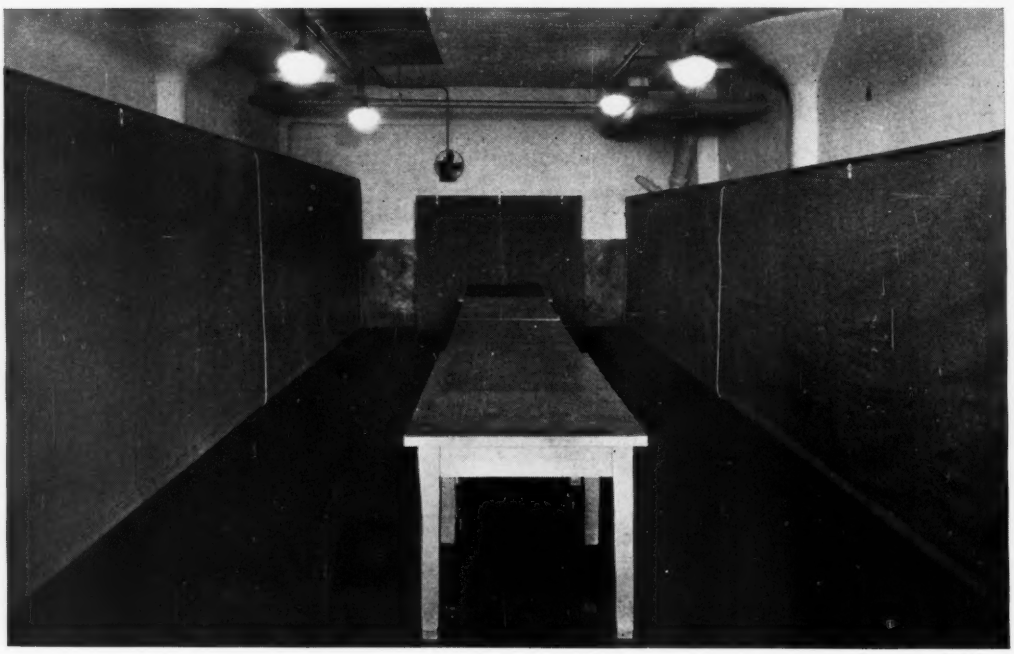
The newly occupied building will be known as Section I. In addition to the street entrances, it may be reached by a corridor off the fourth floor of Section A.

TELEPHONE COMPANIES TO DISTRIBUTE ARTIFICIAL LARYNX AT COST

For some years the Western Electric Company has manufactured the artificial larynx developed by these Laboratories. This device



Views showing the Tracing File at Hudson Street. Utmost protection must be given to the tracings, as damage by fire or water would entail great loss and seriously hamper the work of the Systems Development group. The building itself is fireproof and to protect the tracings against the operation of the sprinkler heads, waterproof curtains, specially designed by Systems Development and Building and Maintenance engineers, are closed down over the cabinets after working hours



makes speech possible for persons from whom the larynx has been surgically removed or whose vocal cords are paralyzed. Prior to about a year ago, when a new type of artificial larynx was introduced, the device was distributed by the Graybar Electric Company. With the introduction of the new type, the sale of the equipment was taken over by the Western Electric Company.

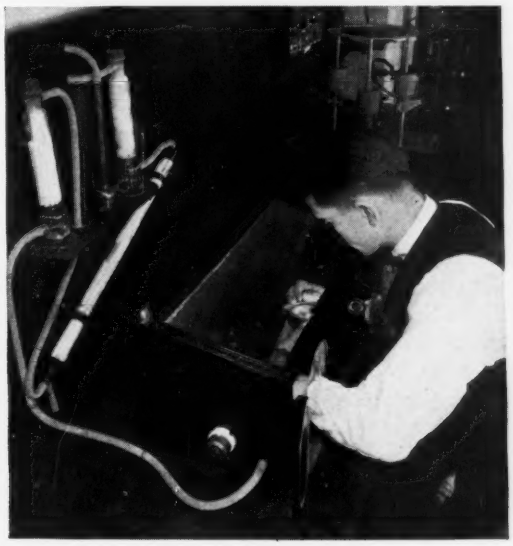
It is now planned to have the various Telephone Companies of the Bell System handle the sale of the apparatus, dealing directly with the persons in their territories who have need of it. It is believed that this method of distribution will make it possible to reach a larger proportion of people who could be helped by the use of the artificial larynx.

The apparatus will be sold at cost, the price of the larynx itself being $22. In certain types of cases, where the larynx has not been removed, but where the vocal cords have become paralyzed, a bellows is used in connection with the artificial larynx. The price of the bellows is $30.

Up to the time the Western Electric Company took over the sale of the artificial larynx, the Graybar Electric Company had sold about 200 of the old type, which is now obsolete and is not being manufactured. Of these, about 100 have been exchanged by the Western Electric Company for the new type, without charge. The cost of these replacements is being borne by the American Telephone and Telegraph Company. It is believed that there are somewhat fewer than 100 persons who are still using the old type of apparatus and any of these who will get in touch with their local telephone company may exchange his artificial larynx for one of the new type, without additional cost.

In addition to replacements, the Western Electric Company has sold about 100 sets of the new type of artificial larynx, making a total of about 200 persons who are now using the improved equipment.

Readers of BELL LABORATORIES RECORD who know or learn of anyone to whom the artificial larynx might be helpful may refer the case to the Commercial Department of the Telephone Company in the exchange where the person resides.



Assembling a condenser microphone in a dust-proof chamber to prevent dust or other foreign material from entering any of the inner chambers of the device. The assembly work is performed by I. H. Baker

LABORATORIES MEMBERS ATTEND DINNER FOR DR. MILLIKAN

MANY members of the Laboratories were present at a dinner given by the New York chapter of the California Institute of Technology Alumni in honor of Dr. and Mrs. Robert A. Millikan at the Hotel Shelton September 4. Dr. and Mrs. Millikan were about to sail for Europe to return the recent visit of Dr. and Mrs. Albert Einstein.

Dr. Jewett made a brief talk at the dinner. Other members of the Laboratories attending were: Eugene Atwater, J. A. Becker, C. H. Bidwell, C. A. Boggs, R. M. Bozorth, C. Floyd Carlson, H. K. Dunn, William M. Goodall, F. Hamburger, A. R. Kemp, A. P. King, R. J. Kircher, M. A. Logan.

FAREWELL LUNCHEON GIVEN FOR C. F. EYRING

A FAREWELL luncheon was given to C. F. Eyring by members of the Sound Picture Laboratory at the Jumble Shop, Eighth Street, on August 13. Dr. Eyring is returning to Brigham Young University to resume his former duties as Dean of the College of Arts and Sciences.

Brief speeches were made by Personnel Director G. B. Thomas, and T. E. Shea, Special Products Engineer, who also attended the luncheon. In replying to the talks Dr. Eyring expressed his regrets at leaving and recalled with happiness his two years' association with the Laboratories and the many warm friendships he had formed in this period. F. L.

Members of Sound Picture Laboratory at farewell luncheon to C. F. Eyring

Hunt acted as master of ceremonies.

Dr. Eyring came to the Laboratories two years ago. He was on a year's leave of absence from Brigham Young University and at the expiration of the year he was prevailed upon to extend his stay.

WORLD'S FAIR OFFICIALS PAY VISIT TO LABORATORIES

Colonel John S. Sewell, Director of Exhibits for the forthcoming World's Fair in Chicago, Professor Henry Crew, in general charge of the Science Exhibits, and Dr. Gordon S. Fulcher, in charge of the exhibits of Physical Sciences, were visitors to the Laboratories on August 27. They discussed plans for exhibits at the fair with H. D. Arnold and M. B. Long.

The visitors were guests of Dr. Arnold and Mr. Long at luncheon and were shown some of the work carried on by the Laboratories in the Sound Picture Laboratory and several other departments of the building.

INFLUENZA 1-9-3-2

By Dr. L. D. Bristol, *Health Director*,
American Telephone and Telegraph Company
New York

No, "Influenza 1-9-3-2" is not a new Exchange number! We are simply calling attention now to the possibility and desirability of getting ahead of next year's crop of this disease!

With some degree of accuracy we are able to predict changes in weather, while such natural phenomena as eclipses of the sun may be foretold with almost mathematical precision. During recent years studies have been carried on which indicate that even epidemics of certain human diseases recur periodically or cyclically. It has been fairly well established that in the average city serious epidemics of measles recur at intervals of three years. In rural districts, where people are less crowded together, such epidemics recur less regularly, and at longer intervals. Thus in most communities the Health Officer is able to predict whether or not the next year will be a measles epidemic year.

From recent statistical studies it appears that while some cases occur every year, influenza or grip also returns to plague us in serious epidemic waves every three years. The years 1920, 1923, 1926 and 1929, according to available information, were years in which pronounced outbreaks of influenza occurred during the winter or early spring months throughout the United States. The year 1930 showed in this periodic cycle a marked falling off in influenza, but during the early months of 1931 the influenza wave showed a higher crest. On the basis of past experience it would seem that the early months of 1932 will bring another high wave of influenza, with a subsequent decline during 1933 and 1934.

Influenza, and other commonly associated diseases of the respiratory system, including the nose, throat and lungs, give rise to most of the sickness disability and lost time from work in the Bell System. Anything we can do to get ahead of and prevent these periodic outbreaks is worth while. Whether or not many em-

ployees of the Bell System are to be temporarily bowled over by the 1932 wave of influenza depends much upon the wisdom and foresight of each individual employee.

The best way to prevent the influenza of February or March, 1932, is to start in September and October, 1931! Without worry, or that panic which comes from waiting too long, let us set about putting our physical houses in order now so that in 1932 we may be riding calmly on top of the influenza wave rather than being buried underneath it with our less precautious friends. Here are a few brief suggestions scheduled by months, which, if followed, should greatly reduce the chances of your contracting influenza in 1932:

October

Continue to lay in a store of as much sunshine vitamin as possible. See your doctor or the Medical Department and have a careful checkup particularly of your nose, throat, and lungs. Follow his advice if treatment of any abnormal conditions, such as enlarged tonsils or chronic catarrhal conditions, is required.

November

Begin to take care in keeping your body warm and your feet dry. Wear enough clothes to be warm and comfortable at that foot-ball game!

December

Encourage adequate ventilation and proper temperature in your living and working quarters. See that the windows in sleeping quarters are kept open at night—don't nail them down for the winter!

January

Cover the cough and the sneeze, and avoid those who do not observe this precaution.

Avoid unnecessary crowds.

Use care in the handling of articles in common, and pay special attention to periodic washing of the hands.

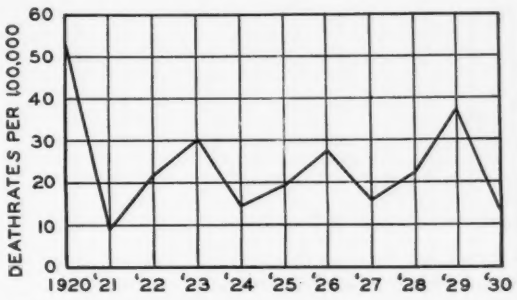


Chart showing the recurrence of influenza epidemics every three years

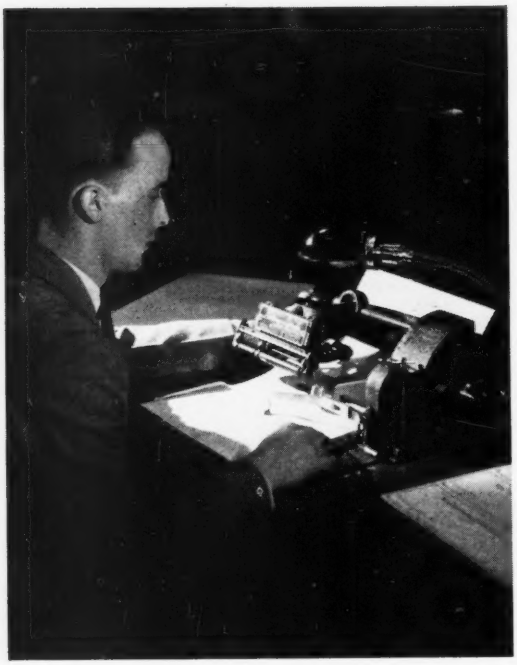
February and March

Keep a daily check on your Health Habits —the eating of nourishing food of proper quantity and variety, and the drinking of enough water; regular elimination; sufficient sleep; daily outdoor exercise; freedom from worry.

April

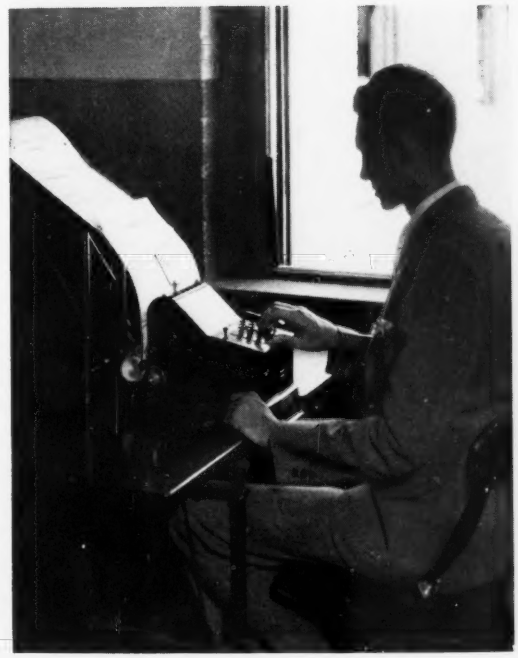
Laugh at old-man Influenza and think of those gardens and fishing trips just ahead!

Preparing the Laboratories' Payroll



Left: On the stub of each check of the strip, the addressograph imprints name, rate of pay, and deductions for A. T. & T. stock, for savings deposits, for insurance premiums, and the like.

Below: When adjustments of these amounts have been entered, comptometers total the amounts on the strips of stubs, for comparison with the totals on the payroll.



Left: When the net amount payable has been calculated, a protectograph embosses that amount into each check.

Above: A check-signer imprints from plates bearing the Treasurer's signature, cuts the checks apart, and stacks them in the proper order so that they can be sealed in envelopes and delivered individually throughout the Laboratories.

The unfailing accuracy of machines supplements the care and skill of our Payroll and Financial Departments

Departmental News

APPARATUS DEVELOPMENT

Special Products

D. T. Bell visited Wingfoot Airport, the private landing field of the Goodyear Zeppelin Corporation in Akron, Ohio, to demonstrate the use of high-powered public address systems as a means of communicating direct voice messages from aircraft to the ground. The Goodyear blimp *Defender* was equipped with an experimental public address system and from a height of 2800 feet Mr. Bell's voice from the blimp could be distinctly heard on the ground. Since the ceiling of the blimp is 2800 feet tests could not be conducted from a greater height. By means of the new acoustic noise meter, measurements were also made of the noise created by the propellers of the *Defender*.

F. A. Coles and R. A. Miller visited Hawthorne to discuss problems on the design and testing of new amplifiers operated with alternating current for sound picture and public address systems. Mr. Miller also visited Nela Park, Cleveland, regarding the development of special lamps for sound-picture application. He was accompanied by N. Insley of the Telephone Apparatus group.

A conference in Washington with engineers of the United States Navy to discuss improved communication systems for navy use was attended by A. F. Price, W. L. Betts, E. G. Fracker, H. C. Curl and O. L. Walter. The effect of gun blasts on transmitters located adjacent to large guns was also considered in the conference.

A. W. Raffill, who has been working in the sound-picture recording group, has left the Laboratories to take up the study of electrical engineering at the University of Wisconsin.

The new re-recording machine developed in the Laboratories for use with sound film is described by J. J. Kuhn in the September Journal of the Society of Motion Picture Engineers. A description of the apparatus will appear in an early issue of the Record.

O. W. Towner visited Boston to inspect Radio Station WEEI of the Edison Electric Illuminating Company.

A. F. Dolan, in charge of the Whippany Laboratory, completed twenty years in the Bell System on July 18.

A demonstration of the radio equipment installed in the Laboratories' Ford plane was made at Hadley Field by Captain A. R. Brooks for R. H. Spaulding, Director of the Division of Aeronautical Education of New York University, who was accompanied by a party of students.

W. Herriott and W. R. Goehner visited Rochester to discuss optical problems.

Telephone Apparatus

W. Fondiller gave a radio talk entitled *Listening In on Youth* from Station WNYC in behalf of the "Y" associations of the Metropolitan area.

Accompanied by H. M. Bascom of the American Telephone and Telegraph Company, E. B. Wood was at Cincinnati to look over switchboard cable installed in one of the central offices of the Cincinnati and Suburban Bell Telephone Company.

C. A. Brigham has been engaged in testing transformer equipment installed in the new 50-kw station of WABC at Wayne, New Jersey.

Materials

H. N. Van Deusen and J. R. Townsend visited the Pratt and Whitney Company at Hartford, Connecticut, and the Jones and Lamson Machine Company at Springfield, Vermont, in connection with problems of precision measurement.

F. F. Lucas attended the first international congress of the New International Association for Testing Materials which met at Zurich, Switzerland, September 6-12. A paper, *Advances in Microscopy* read by him at the meeting was one of eight papers presented by members of the American Society for Testing Materials.

Mr. Lucas also attended the meeting as a delegate of the United States Government. The American Institute of Mining and Metallurgical Engineers appointed him to represent its Institute of Metals Division at the con-

ference on International Research in Zurich.

Manual Apparatus

An inspection of one of the Southern New England Telephone Company's step-by-step offices was made by H. T. Martin, B. O. Templeton, H. O. Siegmund, H. L. Coyne, F. B. Monell, R. M. C. Greenidge and G. K. Smith in a recent visit to Stamford, Connecticut.

The printing telegraph group has moved from 463 West Street to the 12th floor of the Graybar-Varick Building.

Dial Apparatus

J. N. Reynolds and O. F. Forsberg visited Hawthorne in connection with new dial apparatus development.

Drafting and Specifications

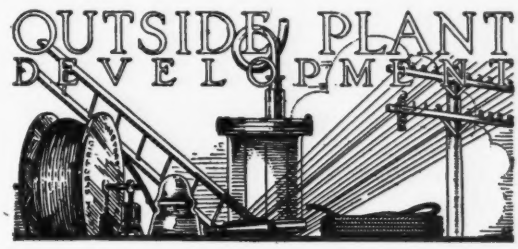
The drafting and Specifications group was grieved to learn of the death of P. J. Hauteberque which occurred on August 25 from a heart attack.

Mr. Hauteberque's service dates from 1911. He was a draftsman for the Empire City Subway Company, a New York Telephone subsidiary engaged in excavation work for

P. J. Hauteberque

underground cables. In 1918 he became a member of the Engineering Department of the Western Electric Company and worked in the Apparatus Drafting group for two years. From 1920 to 1926 he worked on the design of filter coils and loading coils. Since 1926 he has been engaged in specification work on coils and transformers.

Mr. Hauteberque received his elementary schooling in France and held degrees in civil and electrical engineering from the University of Paris.



G. A. Anderegg's association with the Western Electric Company and Laboratories, which for the most part has been devoted to cable development activities both in this coun-

G. A. Anderegg

try and abroad, reached the quarter-century mark on September 3.

Mr. Anderegg is a graduate of Oberlin with a B.S. degree and holds B.A. and M.A. degrees from Harvard. He became a member of the Western Electric Company at Chicago in 1902 and a year later transferred to the development laboratory in New York. In 1904 his former professor at Harvard who was about to take a year's leave of absence, requested him to take over his classes. Mr. Anderegg accepted and after the year at Harvard taught three years more in Ohio State University.

In 1908 he returned to the Western Electric Engineering Department. About a year later he went to Chicago to work on the development of phantom cable suitable for load-

ing. In September 1913 he was given charge of all lead covered cable development.

He returned to New York in 1918 and for nearly a year worked in the Transmission Branch, and for a time had charge of the Physical Laboratory in addition to his cable job. From July 1919 to September 1926 a large proportion of his time was spent in Europe, chiefly in England and Germany in connection with various submarine cable projects. He supervised the manufacture and laying of the 1921 telephone cables across the Florida Straits, the first permalloy-loaded telegraph cable laid in 1924 between New York and the Azores, and two permalloy-loaded telegraph cables laid in 1926, one in the Pacific Ocean from Fanning Island to Suva in the Fiji group, and one from the Azores to Emden, Germany.

At the present time Mr. Anderegg is in charge of the lead covered cable development activities of the Outside Plant Department which includes work carried on at Hawthorne, Kearny and Point Breeze by Laboratories members under his supervision. He is a Fellow of the American Institute of Electrical Engineers and holds memberships in the American Association for the Advancement of Science, the Harvard Engineering Society, the Montclair Society of Engineers and the Telephone Pioneers of America.

L. F. Griffith, a Technical Assistant in the Cable Joining and Maintenance group,

L. F. Griffith

died at his home in Staten Island on August 22. He had been a member of the Laboratories since July, 1929.

Mr. Griffith assisted in studies on cable pressure testing and cable maintenance problems carried on under the supervision of V. B. Pike. He was one of the younger members of the Outside Plant Department and was very popular among his numerous friends who were grieved to learn of his death. He was taking night courses at New York University in connection with his work in Bell Telephone Laboratories.

C. S. Gordon and W. J. Lally discussed the properties of a new insulating compound for drop wire with members of the Manufacturing Department of the Western Electric Company at Point Breeze.

J. G. Brearley observed a cable installation near Binghamton, New York, to note the handling qualities during installation of the new type cable sheath.

Equipment Development

H. M. Hagland visited Washington, to look over the first installation of the No. 554 PBX used for secretarial and apartment-house service.

At Kansas City A. J. Wier attended the installation of equipment for improved test-board supervision for various types of telegraph service.

Donald Ross and R. C. Johnson each completed twenty years in the Bell System during September. Mr. Ross' service date is September 19; Mr. Johnson's, September 23.

After a four months' trip in the field supervising and inspecting the installation of improved program transmission equipment on the Chicago-San Francisco transcontinental lines, E. O. Seiler, A. G. Hill and W. H. Bendernagel have returned to the Laboratories.

J. H. Sole has been working with the General Electric engineers at Fort Wayne on improved voltage-regulating equipment.

V. T. Callahan's work on power apparatus took him to Dayton, Buffalo and Pittsburgh to investigate gasoline pumps and small gasoline engines.

At Morristown C. S. Gray was engaged in transmission tests in connection with the trial installation of cable carrier.

Investigations of new motor-driven alternator sets and cam-type voltage regulators occasioned a brief visit by H. M. Spicer and F. T. Forster to Schenectady.

On September 25 L. Von Nagy rounded out twenty years as a member of the Bell System.

Local Central Office

News was received with much regret of the death of C. V. Metz, a Student Assistant, who was drowned at New Bedford, Massachu-

C. V. Metz

setts, while on his vacation. As a member of the Local Systems Department he was engaged in adjusting relays, testing circuits and other general laboratory work.

He had been associated with the Laboratories since 1929. His home was in Closter, New Jersey.

W. Whitney observed a trial installation of the central office observing set No. 2 in the manual and in combined toll and DSA switchboards at New Haven.

E. L. Vibbard was twenty years a member of the Bell System on September 3.

Toll Development

Tests on signalling arrangements for the new Newark-Philadelphia B-88-50 and H-88-50 cable circuits were made by V. E. Rosene at Princeton and Philadelphia.

T. A. Jones made tests in Washington on the 2A interference suppressor which is designed to reduce interference on carrier telegraph systems caused by lightning adjacent to the lines.

Telegraph test-board problems engaged the attention of G. A. Locke in a recent visit to Kansas City.

E. H. Perkins, at White Plains, made tests on the battery-supply circuits used with the type C carrier telephone system.

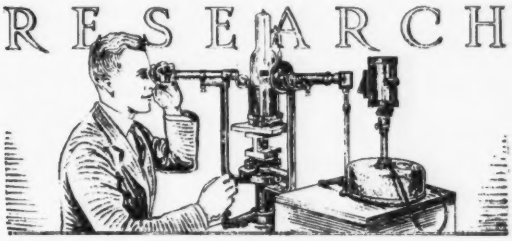
INSPECTION ENGINEERING

Early in September, R. B. Miller visited Binghamton, New York, in connection with current engineering matters.

J. A. St. Clair was at St. Louis during the first week in September to attend with E. J. Bonnesen, Field Engineer in that territory, the inaugural Complaint Review Conference with Long Lines Division No. 5 of the American Telephone and Telegraph Company.

The Inaugural Complaint Review Conference with Long Lines Division No. 8 at Denver was attended by A. G. Dalton of the Laboratories and R. C. Koernig, who is Field Engineer, Denver territory.

A. J. Boesch, Field Engineer, Philadelphia, recently visited the Laboratories to review current problems.



Transmission Instruments

W. C. Jones was in Washington to discuss with members of the Bureau of Engineering questions pertaining to transmission instruments for the use of the United States Navy.

At Hawthorne D. G. Blattner and H. F. Hopkins conferred on matters related to the 570-type loudspeaker included in the public address installation for the Waldorf-Astoria hotel. Mr. Hopkins was also at Washington where he made tests under gunfire of loudspeakers developed for the United States Navy.

A. W. Hayes investigated problems relating to the manufacture of transmitters in a recent visit to Hawthorne.

For the purpose of inspecting a number of 555 loudspeakers N. C. Brower visited the shop of the Western Electric Distributing House at Philadelphia.

Chemical Research

The following papers by members of the Chemical Research Department were pre-

sented at the meeting of the American Chemical Society at Buffalo: *Evaluating Industrial Finishes*, A. E. Schuh; *The Oxidation of Solid Films of Tung Oil* by C. S. Fuller; *The Role of Analytical Chemistry in Industrial Research* by B. L. Clarke; *Oxidation Studies by Rubber, Gutta-percha and Balata Hydrocarbons* by A. R. Kemp, W. S. Bishop and P. A. Lasselle; and *The Effects of Various Accelerators and Anti-oxidants on the Electrical Characteristics and Water Absorption of Vulcanized Rubber Insulation* by J. H. Ingmanson, C. W. Scharf and R. L. Taylor.

PROBLEMS RELATING to the manufacture of tinsel cord occasioned a recent visit by A. R. Kemp and J. H. Ingmanson to Point Breeze.

AT SOUTHINGTON, CONNECTICUT, J. H. White and C. V. Wahl in company with C. R. Moore of the Outside Plant Department visited the factory of Peck, Stowe and Wilcox to confer on tools for Bell System use.

ACOUSTICAL RESEARCH

J. B. KELLY delivered a radio talk under the auspices of Science Service from Station WABC of the Columbia chain. The subject was *Preserving the Voice Compass in Electrical Communication*. Speech sounds consisting of low-pitched vowels and consonants of high

J. B. Kelly

pitch, Mr. Kelly stated, are not heard as pure tones but as complex sounds similar to that produced by simultaneous striking of a group of tuning forks. In the electrical transmission of these sounds they are converted into electrical pulses by the microphone, transmitted over wire or through the ether, and are converted back to sound waves by the receiver. All of the steps of conversion and transmission of the sound and electrical waves, the speaker said, must be made in such a way that the sound at the receiver is intelligibly similar to the sound originating at the transmitter.

Using demonstration records from the Laboratories series, Mr. Kelly showed that the quality of speech was impaired by cutting off first overtones of high pitch and then eliminating the lower pitched parts of speech.

The pitch range is a very important factor, he pointed out, in preserving the intelligibility and naturalness of transmitted speech.

HARVEY FLETCHER gave a demonstration lecture before the Annual Convention of the Telephone Association of Canada at Minaki, Ontario. The subject of his address was *Speech and Hearing as Relating to Electrical Communication.*

G. W. BURCHETT completed twenty years in the Bell System on September 11.

MOVING-COIL telephone receivers and microphones are described by E. C. Wente and A. L. Thuras in a paper published in the Journal of the Acoustical Society of America for July. An article *Audible Frequency Ranges of Music, Speech and Noise* by W. B. Snow is also included in this issue.

RADIO AND VACUUM TUBE

A PAPER *Developments in Short-wave Directive Antennas* by E. Bruce appears in the August Proceedings of the Institute of Radio Engineers. Also in the August issue there is published the article *Radio Transmission Studies of the Upper Atmosphere* by J. P. Schafer and W. M. Goodall.

SUBMARINE CABLE

AT THE Conference on Ferromagnetism at the Schenectady meeting of the American Physical Society, P. P. Cioffi described the magnetic characteristics of hydrogenized iron. Investigations arising out of early experiments with single crystals of iron, Mr. Cioffi stated, have shown that magnetic iron heat treated in hydrogen at high temperatures acquires remarkable magnetic characteristics. The improved characteristics were found to be due to the high temperature hydrogen treatment rather than to the large grain size as first supposed. It is now possible to produce iron having very high initial and maximum permeability in polycrystalline iron.

Whether the improved magnetic characteristics were attributable to purification of the

John Flynn sees to it that no dust impedes the smooth functioning of the apparatus in the Panel Systems Laboratory

iron under prolonged hydrogen treatment or due directly to absorbed hydrogen is conjectural, Mr. Cioffi pointed out. Large grain growth and the softness of iron treated with hydrogen are good evidences for purification. On the other hand, the dependence of magnetic characteristics on the pressure of hydrogen, temperature, thickness of metal, rate of cooling and the time and temperature of heat treatment are consistent with the hydrogen absorption hypothesis. Mr. Cioffi has written a description of the hydrogenized iron process to be published soon in the RECORD.

R. M. BOZORTH also presented a paper at the conference. His subject was: *Barkhausen Effect: Reorientation of Magnetization in Limited Domains.*

ELECTRO-OPTICAL RESEARCH

SEVERAL PAPERS by members of the Electro-Optical Research Department were presented at the meeting of the American Physical Society held at Schenectady, September 10-12. These included *The Vectorial Photoelectric Effect of Thin Films of Alkali Metals* by Herbert E. Ives; *The Photoelectric Effect from Thin Films of Alkali Metal on Silver* by H. E. Ives and H. B. Briggs; *Correlating the Selective Photoelectric Effect with the Selective Transmission of Electrons through Crystalline Surface Structures* by A. R. Olpin; *Thermionic Emission of Caesium-oxide Photocells at Room Temperature* by E. F. Kingsbury.

TRANSMISSION RESEARCH

T. C. FRY and S. A. Schelkunoff were at Point Breeze in connection with mathematical studies relating to toll cable problems.

RADIO AND VACUUM TUBE

A. J. AHEARN read a paper on the emission of secondary electrons from tungsten before the American Physical Society at the Schenectady meeting.

PATENT

H. G. BANDFIELD visited Washington for the purpose of interviewing the Primary Examiner on patent matters.

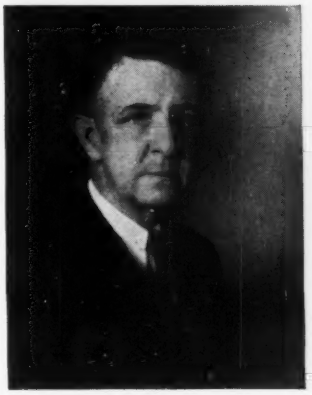
G. M. Campbell was in Chicago, Illinois and Lincoln and Omaha, Nebraska in connection with pending patent litigation.

STAFF

J. M. REILLY completed the twentieth year of his service with the Western Electric Company and Laboratories on September 21.

DANIEL LORDAN also completed twenty years of association with the Bell System. His service date is September 24.

IN THE GENERAL SERVICE Department many important services are handled by T. W. Clarke, who is Merchandise Manager. Mr.



T. W. Clarke

Clarke has been with the Western Electric and Laboratories nearly twenty-five years.

The work of his department falls into four

major divisions. There is the Central Stores in charge of W. R. Stuart which includes the supplying of the laboratories with all materials except those peculiar and special to the various departments. The stores are handled by J. McEvoy, and stock records, which includes an accounting of all stock materials purchased and disbursed, are in charge of M. W. Redmond.

The second division of Mr. Clarke's duties is the Central Instrument Bureau headed by G. Matthews. All precision instruments, again except those special to individual departmental needs, are kept in store and loaned by this department. The third division is traffic services including Shipping, Receiving and Salvage. C. T. Boyles is in general charge. J. Bryson is foreman of the shipping department; J. E. Kelly, receiving; and R. C. Fisher is in charge of salvage.

The fourth division, Models and Samples, is supervised by L. R. Laird. This department maintains a store of development models and samples and furnishes information relevant thereto.

CLYDE DRAKE of the Methods and Audits group and formerly a member of the Personnel Department died at his home in Lyndhurst, New Jersey, on September 12.

Mr. Drake had been a member of the Western Electric Company and Laboratories since 1909. He was graduated from New York University and after a period of training in the Western Electric student course he became associated with foreign sales in 1911. From 1913 to 1916 he was in Hawthorne.

In 1920 Mr. Drake was placed in charge of Order Investigations in New York and later the work of the entire Investigation Department was placed under his supervision. He assumed charge of Cost Estimates in 1923 and a short time later entered the Personnel Department where he became head of Employee Service and served on the Employees' Benefit Committee as Assistant Secretary. He became a member of the Methods and Audits Department on January 1 of this year.

Clyde Drake

The news of Mr. Drake's death was received with much regret in the Laboratories where his passing is mourned by a host of friends.

Communication Group, A. I. E. E.

"The Flow of Electricity in Various Media" will be the subject of a popular exposition to be given by Dr. K. K. Darrow of the Laboratories' Research Department. Dr. Darrow is treating this subject at the invitation of the Communication Group of the New York Section of the A. I. E. E. before its meeting at 7:30 P.M. on October 27 in the Western Union Auditorium, 60 Hudson Street (three blocks north of Chambers Street). Providing a non-technical account of the different kinds of electrical conduction, Dr. Darrow's address will furnish a valuable opportunity to gain a summary knowledge of this interesting branch of physics.

Portable Speech-Input Equipment

By E. G. FRACKER
Special Products Development

IN the early days of broadcasting, program directors, quite naturally, found it desirable to undertake the transmission of programs taking place outside of the studio. Athletic events, speeches by prominent people, or excerpts from plays picked up directly from the stage, all seemed desirable material. To take advantage of such programs, however, required that complete speech-input equipment be installed fairly close to the actual program. In general it was not possible merely to install the necessary microphones at the scene of the program because their output was at too low a level to be transmitted to the studio over any considerable length of circuit without suffering objectionable interference.

Speech-input equipment includes, in addition to the one or more microphones, mixers which combine in the desired proportion the output from the various microphones, and amplifiers which raise the level of combined output to a value satisfactory for transmission to the broadcasting studio. Switching and power-supply equipment is also required at the speech-input point. The equipment originally employed for this service was that designed for use at the broadcasting station and was arranged for permanent mounting on relay racks. Considerable work was required, therefore, to install and connect such rack-mounted speech-input equipment whenever a program was to be picked up at a location not permanently equipped as a pick-up station.

To improve this situation, the units of the rack-mounted system with some modification were arranged in trunks, thereby providing a semi-portable equipment. Its general appearance and method of use are shown in Figure 1. After this 6-A speech-input equipment, as it was called, had been in use for some time, sufficient data was obtained to form the basis of an entirely new design which would combine all the required features in more portable apparatus. Embodying the latest developments in the amplifier art, the resulting equipment is smaller, much lighter, and more convenient than the equipment it supersedes. Omitting accessories, the new equipment is contained in two cabinets of suitcase size, and a small battery box, as shown in Figure 2. It is intended that the battery box, cords, transmitters, subscriber set, monitoring headset and other material required in addition to the amplifier and control cabinet for picking up programs will be carried in an ordinary suit case. One of the major units is the 710-A Control Cabinet which is used as a mixer, and the other, the 55-A Amplifier which increases the output of the mixer to a level suitable for transmission to the broadcasting studio. The

55-A Amplifier may be used alone when only two microphones and no mixing is required.

The development of these new units required consideration of many unusual factors and the solving of many electrical and mechanical problems. The new equipment not only serves its purpose as well as and even better than the equipment it replaces, but it occupies a space of only 3.7 cubic feet and weighs but 149 pounds as compared with 12.1 cubic feet and 558 pounds for the equipment illustrated by Figure 1. The net result is a considerable saving in operating time, in first cost, in transportation time and expense, and a reduction in the personnel.

The control cabinet, at the left of Figure 2, has receptacles on its left end for connection to three microphones, and on its face, has three potentiometer dials for regulating the relative volume of each microphone. Directly beneath these dials are three lever-type keys used for measuring the current in either button of two-

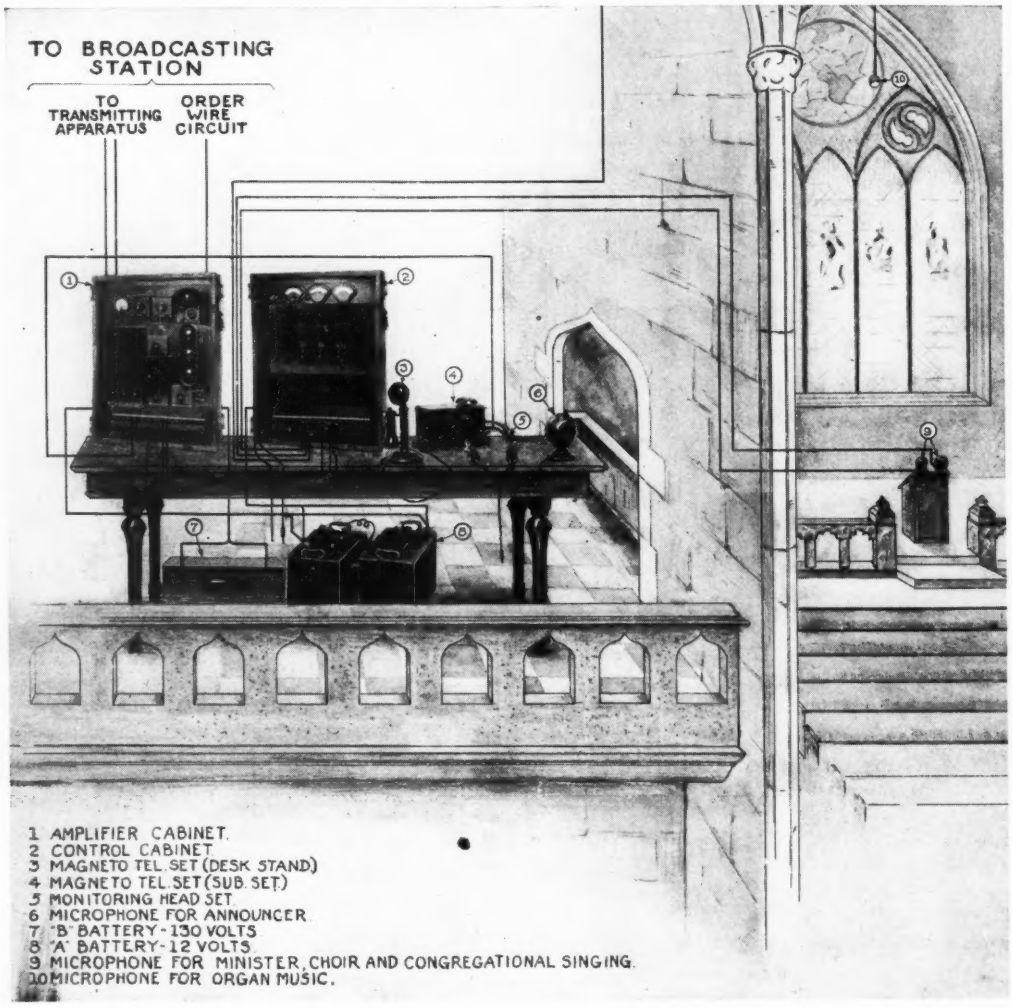


Fig. 1—*The use of speech-input equipment is shown by this schematic illustration of the semi-portable* 6-*A equipment*

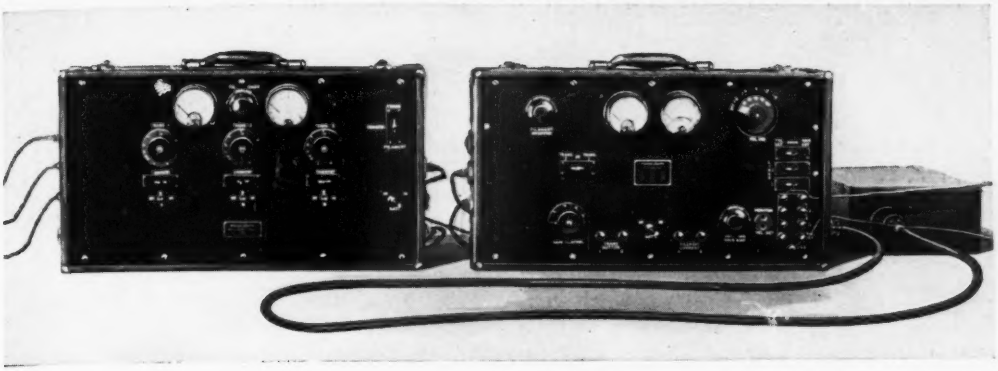


Fig. 2—The new speech-input equipment, reduced to a much smaller compass, is completely portable

button microphones, and beneath them are three other keys for switching on or off each of the microphones. An ammeter is provided which by use of a lever-type key may be used for measuring either the microphone-button current or the filament current of the vacuum tube employed as a single-stage amplifier. A volume indicator, a battery switch, and a filament rheostat complete the equipment on the front panel.

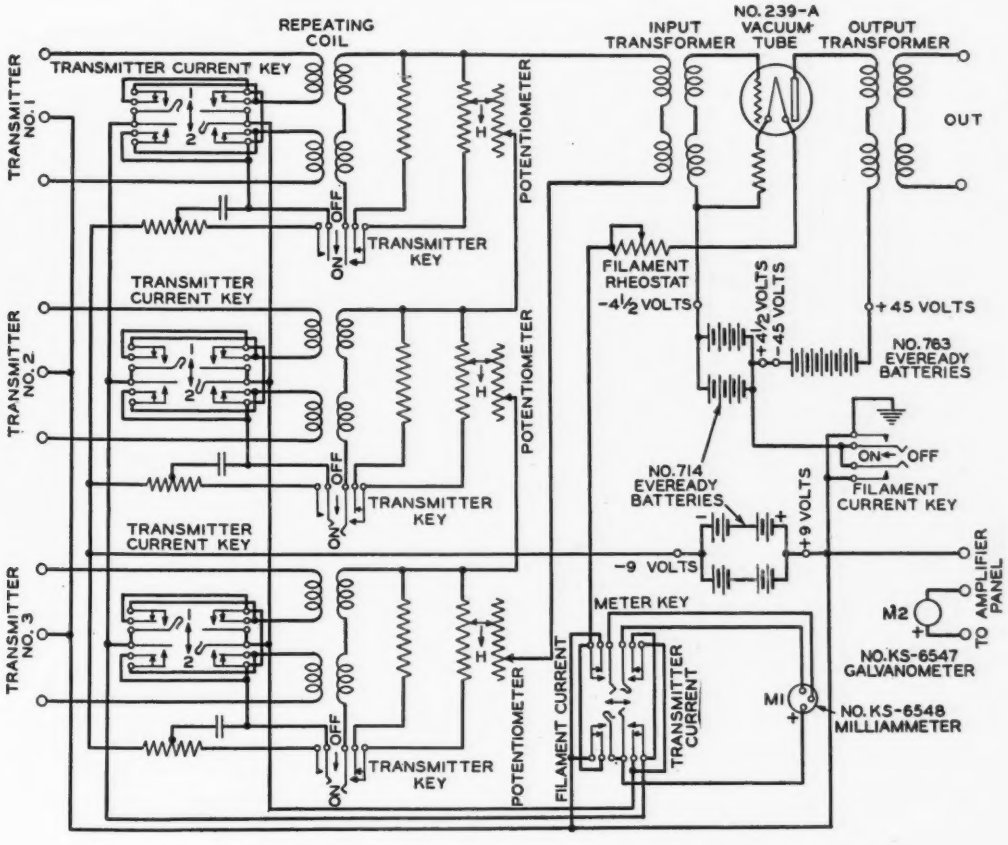


Fig. 3—Schematic for control circuit of speech-input equipment

A schematic of the control circuit is shown in Figure 3. The amplifier is designed to make up for the loss in the mixing potentiometers only. Since the 239-A tube is employed, only small batteries are required and these are contained within the cabinet. The interconnected potentiometers serve to mix the output of the three microphones in any desired proportions, and their output, through the amplifier, furnishes the input to the main amplifier contained in the other cabinet.

This amplifier cabinet, shown on the right of Figure 2, carries on the left end receptacles for two microphone connections — one of which would be connected to the control cabinet — and on the other end a five-point receptacle for connection to the battery box. Terminals are provided on the lower right-hand corner for three lines to broadcasting stations, and for a telephone set. In addition, two jacks are furnished: one for monitoring and the other for a telephone. An ammeter and a volume indicator are mounted on the upper part of the face, and dials for gain control, filament current, and two for control of the volume indicator are also provided. In addition there is a lever-type key for connecting either of the two microphone receptacles to the amplifier, a battery switch, push keys for measuring filament or microphone current, and three lever-type keys, on the right, for connecting any of the outgoing lines either to the output of the amplifier or to the telephone set so that any line may be used as an order wire.

A schematic of the amplifier circuit is shown in Figure 4. A three-stage amplifier is employed, the last stage of which is connected push-pull. A transmission gain of about 67 db is provided at 1000 cycles, and over the frequency range from 40 to 7000 cycles the variation in gain is not more than ± 1.5 db. The final push-pull stage minimizes distortion and makes possible an output level of + 8 db.

The volume-indicator circuit includes a potentiometer for adjusting the initial grid bias of the vacuum tube and a six-point dial switch for select-

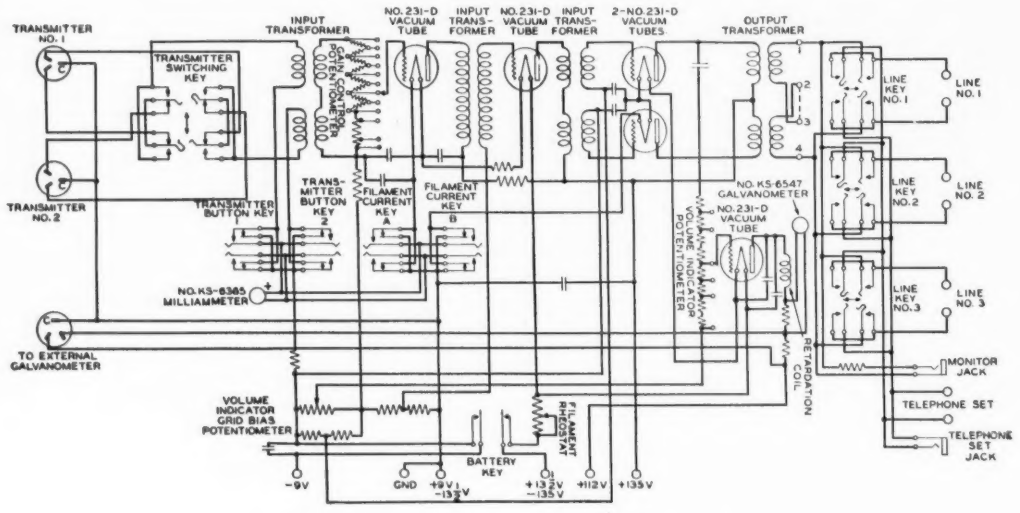
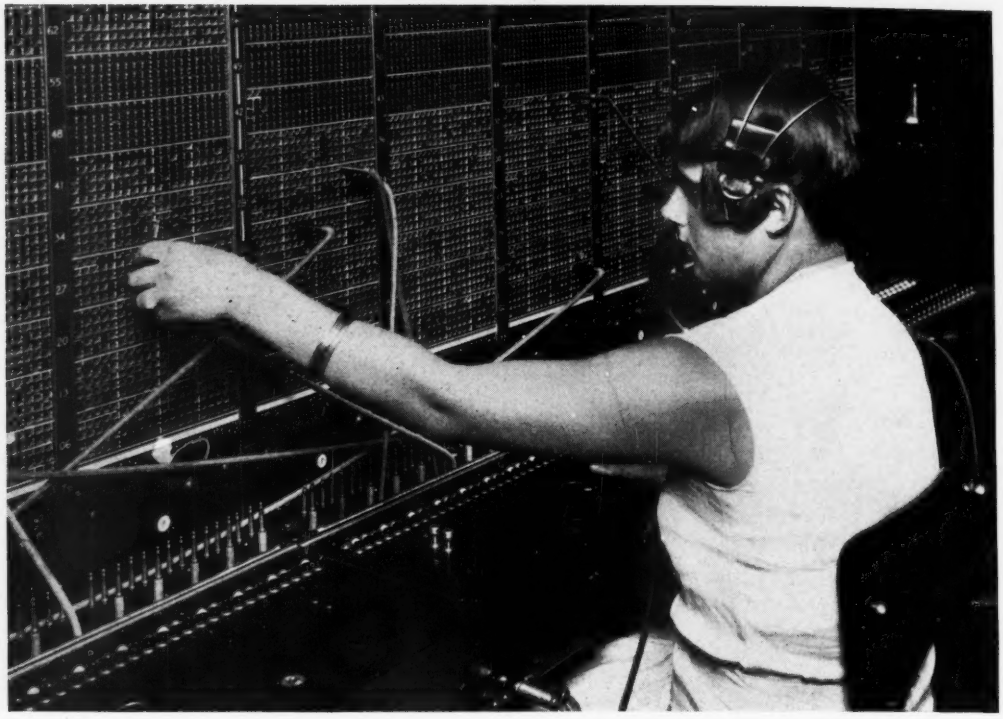


Fig. 4—Schematic diagram of the amplifier circuit

ing the proportion of the output voltage to be applied to this tube. The points are marked to correspond to the level being transmitted when the switch is adjusted properly in conjunction with the reading of the meter. A three-point receptacle for connecting the circuit to an external volume indicator, so that the output level may be observed remote from the amplifier, is also supplied. The volume indicator on the control cabinet is commonly employed for this purpose.

Cases of both control and amplifier cabinets are made of plywood covered with fibre. Structural members have, wherever possible, been made of duralumin or aluminum to make the cabinets as light as possible. The cabinets, weighing less than 60 pounds apiece, are arranged in the form of suitcases and one man can carry both for short distances. With this development, completely portable speech-input equipment is available which may be carried by train or taxicab to the required location on short notice so that programs may be broadcast with a minimum of delay where there is no permanent speech-input equipment.

Reducing the diameter of a quartz ring used for a crystal oscillator. Carborundum in the form of paste and applied with a brush is used, in this instance by George Hecht in the Canal Street laboratories of the Research Department



The Panel Bank

By C. W. McWILLIAMS
Telephone Apparatus Development

IN a manual office the subscribers' lines and the trunks to other offices terminate in jacks in front of the operators. Such a collection of jacks in a manual board, is known as the multiple — subscribers' multiple or trunk multiple, as the case may be — because each line or trunk is connected in multiple to a number of jacks along the face of the board so that each may be accessible to any of a number of operators. In the panel type of dial system, the panel bank, shown in Figure 1, serves the purpose of the jack multiple in the manual system. In place of the jacks are groups of contact terminals. Sixty multiple connections, thirty on each side of the bank, are provided for one hundred lines in the particular bank shown, which is the one used with most of the panel frames. Not all banks have the same number of lines and multiple connections but all are similar in general construction.

Each jack of the multiple of a manual board has three connections to it, known as the tip, ring, and sleeve conductors. These terms take their names from the parts of the plug used to complete a connection to a cord circuit. One connection is made by the metal tip of the plug, one by an insulated metal ring just back of the tip, and one by the metal sleeve that forms the main surface of the plug. Each appearance of a line in the panel bank similarly has three contact terminals,

and they are given the same names—the sleeve is the middle contact and the tip and ring are the two outer ones, the ring being to the right.

A complete panel bank is correspondingly built up of groups of three punched-brass strips, one of which is shown in Figure 2. These are arranged one above another with strips of insulating paper, impregated and coated with an asphaltum compound, between adjacent punchings. Each group of three consecutive metal strips forms the multiple for a single line or trunk so that three hundred punchings are required for one hundred lines. The assembly is held together under compression by rectangular metal strips at the top and bottom, and ten tie rods which pass through the entire bank of punchings and each metal end piece. The rods are insulated with hard-rubber bushings. In addition to the thirty contacts on each side of the punching, a soldering lug is provided at each end to which the connections to other banks or to the lines or trunks are made.

In the manual system connections to the jacks are made by the plugs, as already mentioned, but in the panel system brushes, shown in Figure 3, are employed to make connection to the terminals. Each brush has shoes that make contact with the terminals and is carried up along the vertical rows of contacts by an elevator rod. Each rod usually carries one brush per bank but the number of rods depends on the type of frame and the amount of traffic. The arrangement of a complete frame is shown in Figure 4.

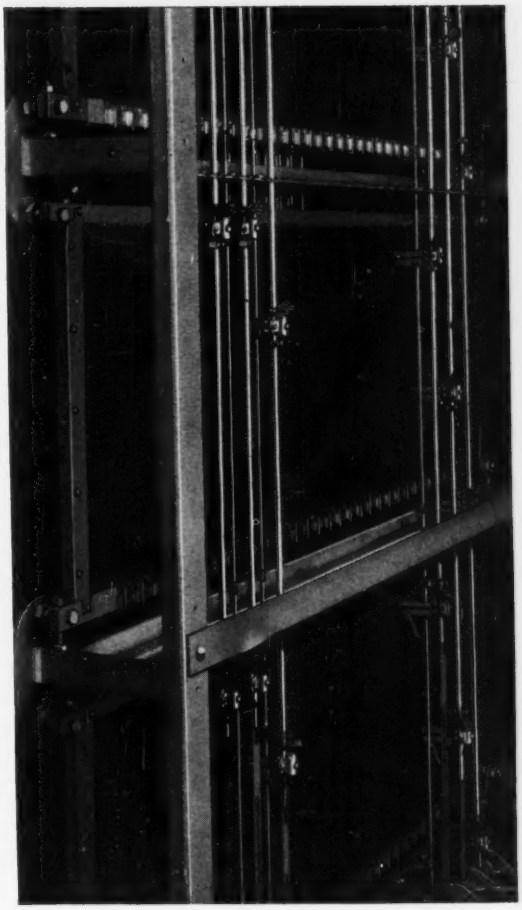


Fig. 1—A one-hundred line bank providing for 30 multiple connections on each side is about 40 inches long, 15 inches high and 1 inch thick across the tips of the contacts

To guide the brushes along the proper path as they are lifted from below the bank, six die-cast combs are

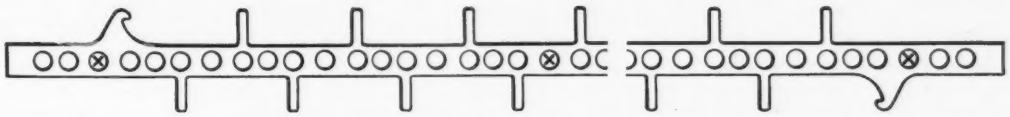


Fig. 2—One of the punchings that compose a panel bank. Three types are used on each bank: one each for the tip, ring, and sleeve terminals. They are all alike except for the location of the terminals and soldering lugs

Fig. 3 — Contact with the brush is made through a narrow metal strip running across the middle of the insulated shoe

mounted on each side of the bottom horizontal bar. These are evident in Figure 5. Each comb provides prongs or teeth for guiding five brushes. To perform a similar guiding function at the top of the bank, should any of the brushes travel beyond their normal range, eight of the punched bank strips, without paper insulation, are mounted just below the top horizontal bar.

The total pile-up of a bank thus consists of 308 metal strips and 302 paper strips. To maintain this high thin pile in proper alignment, and to the very close spacing tolerances, is a manufacturing attainment of great magnitude. It is not particularly difficult to keep the terminals in line vertically because the metal strips — being punchings — are all alike, and the holes for the tie rods, and the terminals themselves naturally fall in line. To maintain the correct spacing between horizontal rows, however, and to hold the tips of all the terminals on a side in a true vertical plane is much more difficult. One of the greatest obstacles to be overcome is the swelling or shrinking of the paper insulating sheets with variations in

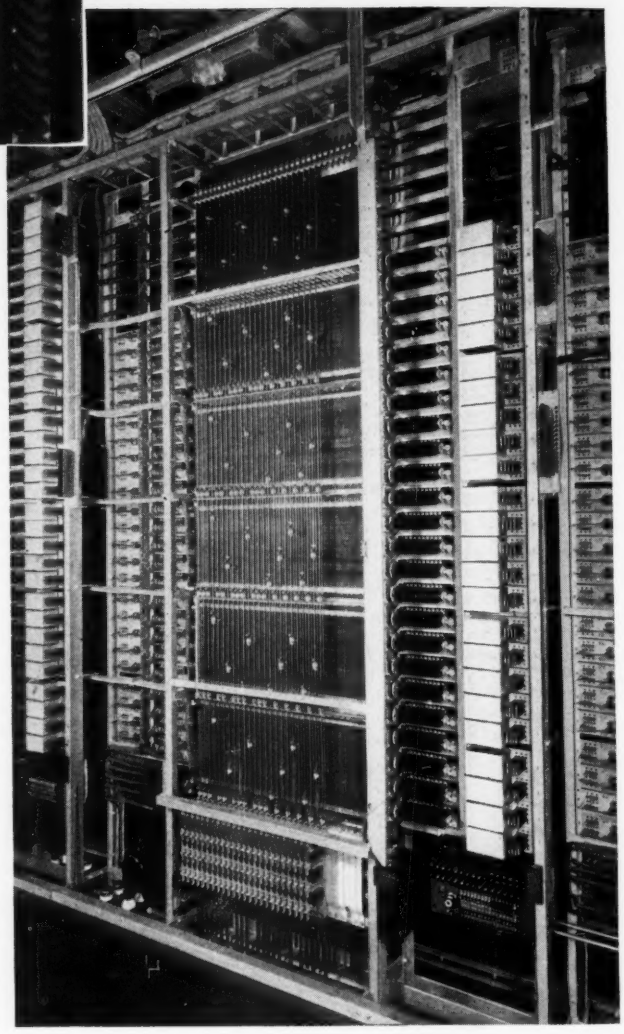


Fig. 4 — A typical panel frame carrying five banks each of 100 lines. The number of elevators used depends on the traffic, but the maximum number is thirty on a side

either temperature or humidity.

Although the contact strips for most of the banks used are of brass, it has been found desirable to employ bronze strips for certain banks that are subjected to very heavy duty. Banks for the link frames that associate senders with district selectors are typical of those requiring bronze strips. Because of the vital function of the bank in the operation of the panel system, studies are continuously being made to discover improvements in either materials or construction. With the very large demand for banks, in the neighborhood of a million dollars' worth a year, it is evident that extensive investigations looking to continued improvement are fully warranted.

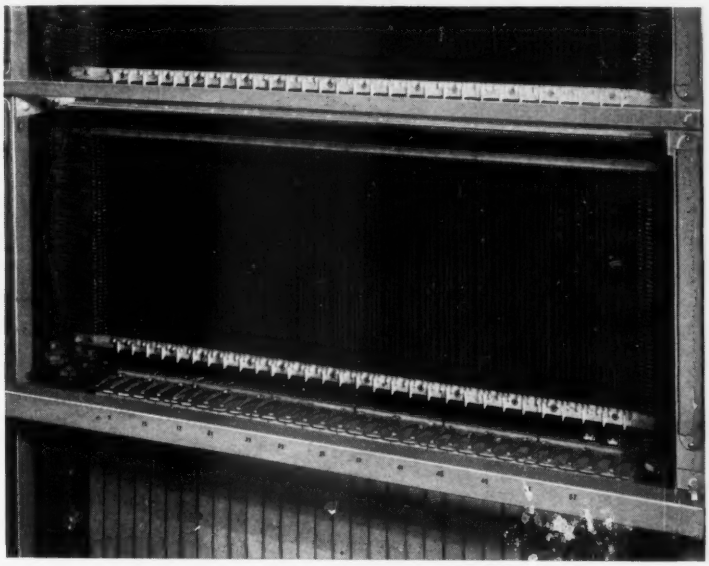


Fig. 5—Die-cast metal combs guide the brushes to the terminals of the banks

Police of New York State Adopt the Teletypewriter

By R. B. SIMON
Equipment Development

DURING September a statewide teletypewriter system was put in service by the New York Telephone Company for police use. Switchboard equipment recently developed by the Laboratories is installed at six central locations — Albany, Oneida, Batavia, Sidney, Malone, and Hawthorne — to serve local districts. Although it is physically possible in most cases for any sending station to be connected with all other stations, the system will be operated generally on the basis of the district control points giving the required distribution to messages originated by stations within their districts.

The extent of the system as it exists at the present time is shown in Figure 1. Initially a total of 86 teletypewriters is being operated. Approximately 3,300 circuit miles connect 65 district stations, including municipalities and police posts. Broadcasting facilities are also provided so that a general alarm may be sent from any switchboard location to all stations in that particular district, and at the same time to all other districts. This new system gives the police of New York a powerful tool for the apprehension of criminals, and is another recognition of the great value of the teletypewriter, which in recent years has found a wide variety of applications.

The heart of the system is the 65-B-1 teletypewriter switchboard which is used for the first time in this installation. In general it functions in a manner very similar to the usual manual switchboard. Jacks, and call and busy lamps, for all lines appear in the board before the operator, and cords, keys, and disconnect lamps are mounted in the keyshelf. One section of the new board, with a capacity for forty lines and ten cord circuits, is installed in each of the six central locations. The appearance of the board as installed at the Hawthorne barracks of the state police is shown by the photograph at the head of this article. Equipment for only ten lines and three cords is included in this installation. Either two-way or one-way communication may be carried on by the attendant depending on whether the particular outlying station is equipped with a sending-receiving or with a receiving-only teletypewriter.

Four rows, each of ten line-jacks, may be mounted in the lower part of the switchboard in front of the attendant. Directly above each row of jacks is space for a row of lamps consisting of a white calling and a red busy lamp for each line. In the upper part of the board, room is provided for two rows each of twenty broad-

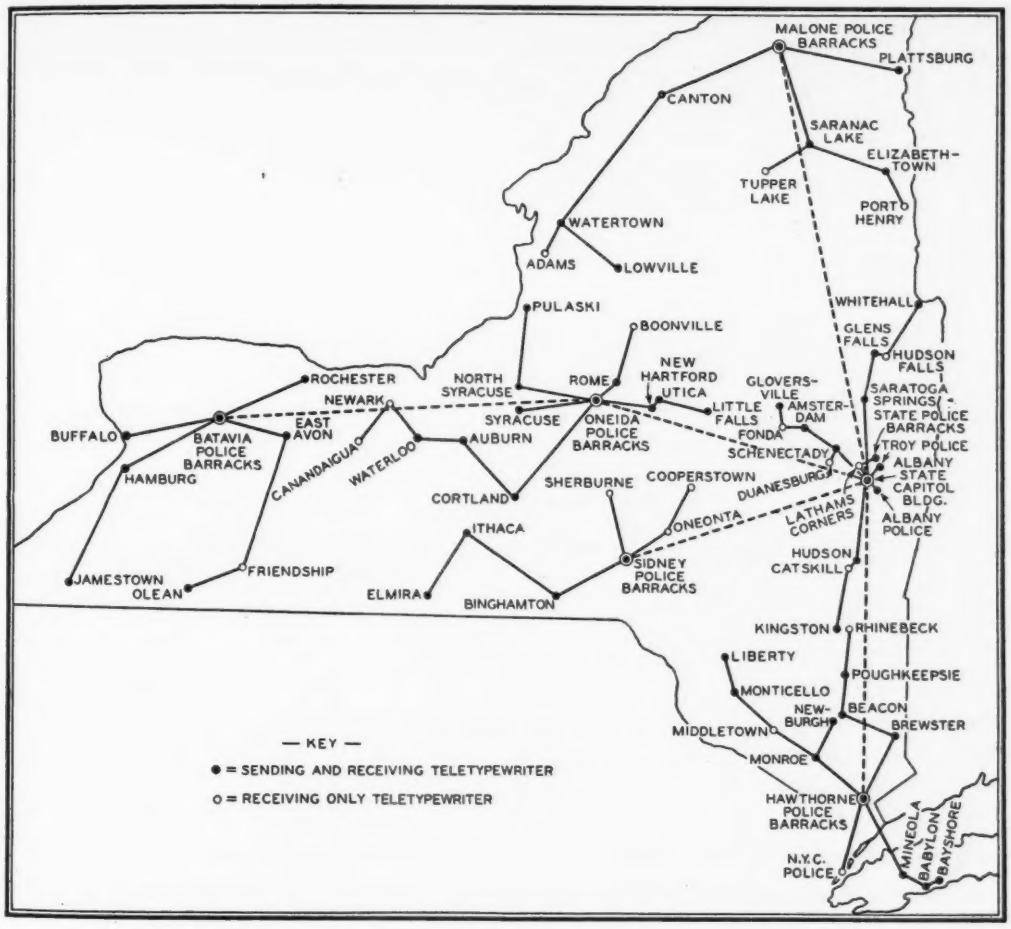


Fig. 1—The entire state is divided into six districts each served by a 65-B-1 P.B.X.

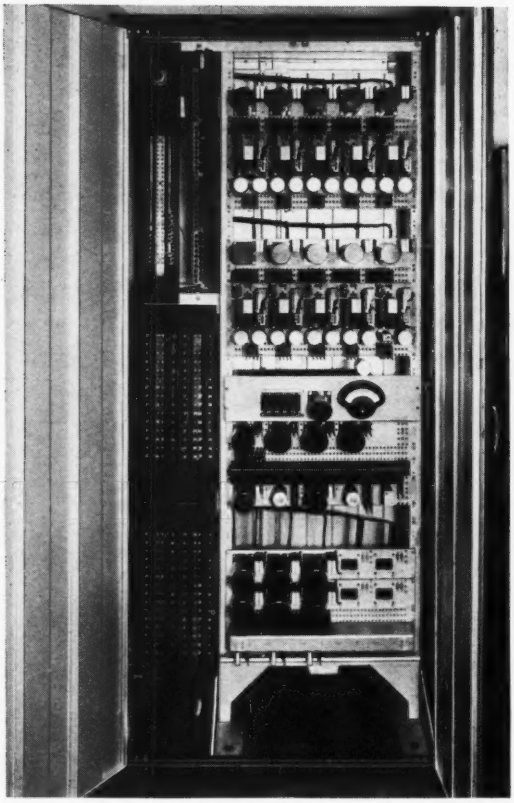


Fig. 2—A typical equipment cabinet associated with the 65-B-1 P.B.X.

cast keys and green broadcast lamps, one for each line. In the keyshelf there are positions for ten cords with calling and answering plugs, and with white disconnect lamps, together with a two-position key for each cord circuit used for connecting either of the two operators' teletypewriters with the cord. At the left of the jacks on the face of the board — hidden by the teletypewriter in the photograph — is a broadcasting jack, a common broadcast key, a common acknowledgment lamp with a green cap, and a red busy lamp used for general broadcasts. At the right of the line jacks is a night alarm key which switches in an audible signal when the attendant is absent from the board.

To originate a call the attendant at a branch station, by operating a key on his teletypewriter, opens the line for about a half second, which lights the calling lamp above his line jack at the switchboard and starts the motor of the calling teletypewriter. Here the attendant responds by inserting the answering end of an idle cord into the calling jack. This extinguishes the calling lamp and lights the red busy lamp. Then by operating the key associated with the cord, either of the two teletypewriters at the switchboard may be connected to the calling line. Information as to the line wanted is immediately transmitted between the teletypewriters at the

Fig. 3—A typical installation of power equipment located at the Batavia barracks

calling station and at the switchboard, and the attendant completes the connection desired with the other end of the cord, which lights the busy lamp of the line called. By opening the line momentarily with the key on his teletypewriters, the switchboard attendant starts the teletypewriter at the called station and communication proceeds whether an attendant is present at the called station or not.

At any time during the sending of the message the receiving station may interrupt by operating the break key on his teletypewriter. This allows him to communicate with the calling station to secure any additional information he may desire. A disconnect signal is sent by an operation of the break key for about five seconds, which lights the disconnect lamp of the cord circuit. The attendant at the switchboard then takes down the connection after first stopping the teletypewriter at the called station.

ALARM NO. 1234 FEB.7 1931 11 13 P. M.
ARREST AND HOLD FOR GREENBURG,3 MEN, IN A COUPE, ALL ARMED, ARE WEARING CAPS, THEY HELD UP A DRUG STORE IN GREENBURG, ARE HEADED TOWARDS TARRYTOWN.

PTL Σ DOWDALL

FEB. 7 1931 NOTE 11 38 P.. M.
IN REFERENCE TO ALARM NO. 1234, AUYO IS AN MODEL WITH A HIGH BACK WINDOW ON RIGHT SIDE IS CRACKED. AUTHORITIES ARE NOT CERTAIN AS TO WHETHER THERE ARE TWO OR THREE MEN IN IT. DISC. OF ONE IS AS FOLLOWS NO. 1 WHITE ABOUT 25 YEARS OLD,5 FT9 INCHES TALL, SLIM BUILD WORE A GREY OVERCOAT.

FEB.8,1931 QMPU

FEB.8,1931 1.07 A. M.
8, REFERENCE TO ALARM NO.1234 MEN APPREHENDED BY THE NEW YORK STATE POLICE TROOP K.

LIEUT. SULLIVAN

Fig. 4—Three successive teletypewriter messages recently transmitted over the Westchester County system

The present plan of operation is to have the switchboards handle the broadcasts in all cases. If the broadcast is to include only part of the stations, the broadcast keys of the lines to be used are operated. These light the broadcast lamps associated with their lines, their red busy lamps, and the common acknowledgment lamp. The attendant then inserts the calling end of a cord into the broadcast jack, when the broadcast may proceed. If the broadcast is to go to all stations, the attendant operates the common broadcast key instead of the individual keys, but the operation is otherwise the same.

Relay equipment for the switchboard is mounted on floor-type racks and enclosed in metal cabinets as shown in Figure 2. Power equipment, enclosed in similar cabinets, consists of a 48-volt negative, and 130-volt positive and negative motor-generator sets for each switchboard. A typical installation is shown in Figure 3.

This is the seventh teletypewriter system to be employed in state-wide police service. In addition there are

at present in service twenty-three municipal and six county systems, some of which have already been mentioned in the Record.* The great advantage of such systems in cutting off the escape of criminals is illustrated by the three terse teletypewriter messages given in Figure 4. The first two of these successive messages were outgoing from White Plains to Hawthorne, and the third a reply to White Plains. These messages, obtained through the courtesy of Lieutenant Sullivan, were sent over the Westchester County system which has been in service for some time between police headquarters at White Plains and the Hawthorne barracks of Troop K. They suggest the even greater advantages that could be obtained from a country-wide system.

* RECORD, *January*, 1931, *p.* 214.

On September fifteenth the state-wide teletypewriter system described in the above article was formally opened by Governor Franklin D. Roosevelt from the state capitol. At the opening ceremonies commnication was held between state governors, mayors of principal cities, and police officials over an interstate connection linking New York, New Jersey, and Pennsylvania. Some 550 *stations were interconnected including* 299 *in New York,* 132 *in New Jersey and* 118 *in Pennsylvania. Representatives were also present from Connecticut and Rhode Island where similar state-wide teletypewriter systems are being installed.*

Contributors to this Issue

E. K. Jaycox became a member of the Western Electric Company in September, 1919, as a technical assistant, and early in 1920 was assigned to the Special Research Department where he is still employed. He has been engaged for the most part in making studies of thermionic phenomena and in the development of related apparatus of which the ionization manometer described in this issue is an example. In addition to a three years' course as a technical assistant, he has taken studies for five years at evening sessions of the College of the City of New York.

At the present time Mr. Jaycox is occupied with the development of apparatus for use in measuring small thermionic currents.

E. K. Jaycox

Interested in telegraphy from boyhood, G. C. Cummings — after varied experiences as telegraph operator for railroads and commercial companies — became wire chief for the Western Union Telegraph Company in 1903, testboard man for the American Telephone and Telegraph Company in 1904, and General Communication Manager for the Chicago, Burlington and Quincy Railroad Company in 1905. Here, among other things, he was engaged in perfecting telephone train-dispatching systems. After a four year retirement because of a nervous breakdown, he returned to the Western Union Company to obtain experience in multiplex printing telegraph systems. In 1917 he joined the Engineering Department of the Western Electric Company, now Bell Telephone Laboratories, where he has since been engaged in the development of our various modernized telegraph systems. With 21 patents to his credit and 14 more cases pending, he is at present in charge of the group engaged in direct-current telegraph developments.

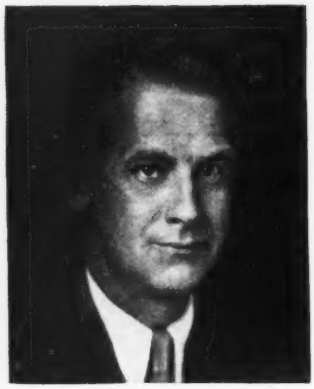
G. C. Cummings

In 1925, after receiving the B.S. degree from Harvard College, A. N. Holden joined the General Methods group of the Laboratories Staff Department. In 1928 he transferred to the Bureau of Publication, where he has since assisted in the preparation of Bell Laboratories Record and other material for publication.

A. N. Holden

F. Lohmeyer joined the

F. Lohmeyer



C. W. McWilliams

E. G. Fracker

R. B. Simon

Laboratories in 1920 and became associated with the Apparatus Drafting Department. After several years of layout and design work on general telephone apparatus, he took part in the design of the 500-watt radio telephone transmitters for the U. S. Navy. Later he transferred to the Specification Group of the Apparatus Department. In 1925 he joined the Apparatus Development Department where he was occupied with the design of tools for apparatus maintenance. Following this he took over the development of the "B" type handset mounting and at the present time is working on the development of anti side-tone subscriber sets and transmitters for the business offices of telephone operating companies.

C. W. McWilliams, after completing work at the Newark Technical School in 1910, entered the Engineering Drafting Department of the Laboratories — at that time the Engineering Department of the Western Electric Company. Two years later he transferred to the machine switching group and was engaged in the original development of the panel apparatus subsequently installed in the semi-mechanical office in Newark. From 1916 to 1919 he was engaged in supervising life-test studies in the panel apparatus laboratory. Since that time he has been occupied with the development of apparatus for the panel system.

E. G. Fracker entered the Apparatus Development Department of the Laboratories in 1918 and took part in the development of radio-telephone transmitting and receiving equipment for the Army and Navy. Later he undertook developments of a similar nature for general commercial use. He is now supervisor of a group engaged in development work for public address, music reproducing and sound picture systems. The mechanical design of amplifying and other apparatus for these systems falls within the scope of their work.

R. B. Simon received a B.S. degree in electrical engineering from the Agricultural and Mechanical College of Texas in 1913. Joining the Western Electric Company at Hawthorne that same year he took the Student Training Course and then entered the Equipment Engineering Department. During 1918 and '19 he was with the 37th Engineers of the United States Army, and after the armistice was associated with the Texas Oil Company for a year. In 1920 he joined the Laboratories where he has been engaged in equipment engineering and trial installations.